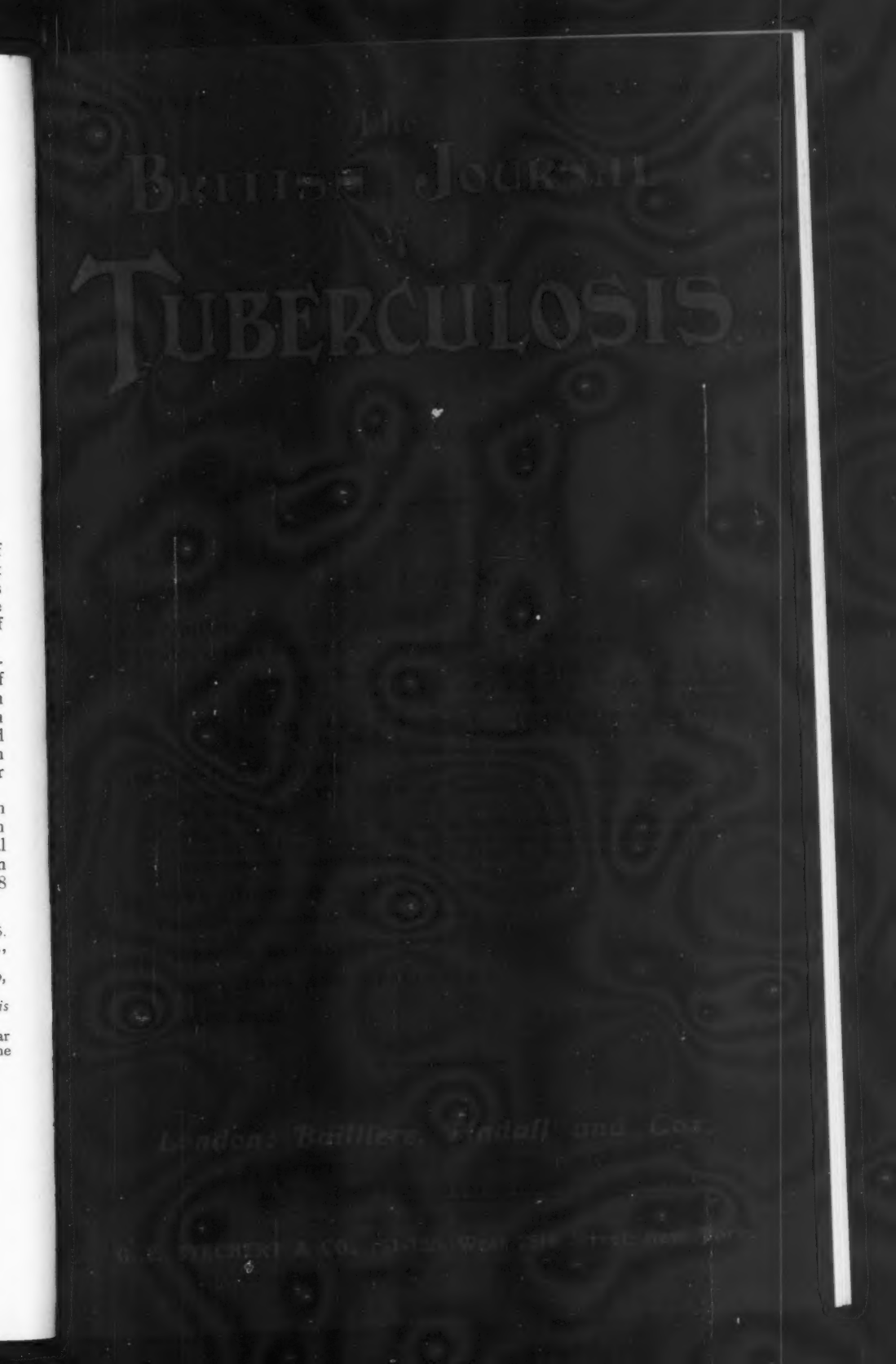
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# SYMPOSIUM.

## TUBERCULOSIS AMONG COMBATANTS AND WAR-WORKERS.

THE BRITISH JOURNAL OF TUBERCULOSIS during these anxious war times has sought to render effective and patriotic service by the presentation of opinions from experts concerning present-day aspects of the tuberculosis problem.[1] In the editorial section of our last issue we urged on the Government the immediate appointment of "a representative Committee, or an authoritative Commission, to consider the whole tuberculosis problem in relation to war and probable after-war conditions." The further evidence put forward in the present symposium indicates the increasing importance of a full consideration of all questions relating to tuberculosis, as they relate to the protection of the Empire under existing conditions.

[1] The symposium on "War and the Future of the Tuberculosis Movement" appeared in THE BRITISH JOURNAL OF TUBERCULOSIS for January, 1916, Vol. X., No. 1, and the following were among the contributors: Sir Thomas Clifford Allbutt, Prof. E. W. Hope, Dr. A. Maxwell Williamson, Dr. J. C. Thresh, Dr. H. Hyslop Thomson, Dr. Herbert de Carle Woodcock, Dr. Jane Walker, Dr. J. J. Perkins, Sir John W. Byers, and Major Waldorf Astor, M.P. The symposium on "The Tuberculosis Movement under War and After-War Conditions" appeared in the Journal for January, 1917, Vol. XI., No. 1, and contained opinions from the following: Dr. T. D. Acland, Sir John Moore, Dr. J. Lumsden, Dr. Halliday Sutherland, Dr. E. W. Hope, Sir William J. Thompson, Dr. Cecil Wall, and Dr. George A. Crace-Calvert.

## From Sir CLIFFORD ALLBUTT,

K.C.B., M.A., M.D., D.SC., LL.D., F.R.C.P., F.R.S.,

Regius Professor of Physic in the University of Cambridge; Member of Committee of National Research; President British Medical Association; Hon. Colonel R.A.M.C.

A short time ago a few of us had the honour of an interview with Mr. Lloyd George on the whole question of the continuance of therapeutical methods in the cases of all soldiers maimed or undermined in health during the War, and declared unfit for further service. Some of the Labour representatives and Sir Alfred Keogh, Director-General, Army Medical Service, were present at the interview. Our deputation was received, not only with courtesy and cordiality by Mr. Lloyd George, but also with sympathy. Indeed, as War Minister, he did not hesitate to express his adherence to our request so far as the other conditions of the Service would permit. But there are administrative difficulties which need careful handling and much reconsideration. We left the War Office very hopefully; feeling assured that what could possibly be done to perpetuate the apparatus and method of cure in disabled soldiers would be done.

So in respect of one department of this relief—namely, in the department of Tuberculosis—every facility possible will be granted, and we may work on as ardently and actively as we have done hitherto.

An institution for after-care of tuberculous patients discharged from sanatoriums, has been established at Bourn, in the County of Cambridge, under the efficient and zealous initiative and management of our Tuberculosis Officer, Dr. Varrier-Jones. By the generous benefaction of a gentleman whose name will, I hope, shortly appear—one well known in the warfare against Tuberculosis—this institution will be substantially extended and reinforced. As one who for a generation has been protesting against the big leak in our anti-tuberculosis campaign, due to the free circulation of the incurables, I trust these new measures may in time help to stop it.

## From PHILIP BOOBBYER,

M.D.,

Medical Officer of Health for Nottingham; Examiner in Public Health for the University of Birmingham.

The present is in all respects a fitting time to discuss the question of existing and future measures for dealing with tuberculosis among sailors, soldiers, war-workers, and others, because cases of the disease in all these classes are continually occurring, coming to our notice, and

requiring to be dealt with. Our present system of treatment and general care and control is to a large extent unsatisfactory, and, notwithstanding the duties and distractions of these critical days, we have now probably more leisure for thinking out our best line of policy and practice in regard to this matter of tuberculosis than we shall have when peace is declared, and all the social and industrial confusion inseparable from demobilization is upon us.

Our existing system will, of course, form the basis of future schemes for dealing with tuberculosis. The principal defects of this system are: (1) That no adequate provision is made for dealing with advanced cases, which, from a preventive standpoint, are the most important of all, being ordinarily the most fruitful of mischief. (2) That sanatorium treatment as at present provided, while highly useful as an object-lesson to patients and to the general public in the health-giving properties and innocuousness of open-air treatment, is seldom of really permanent advantage to patients, on account of the comparatively short periods for which they are commonly sent to sanatoria. (3) That no open-air labour colonies or farms are provided for enabling convalescent patients, after a course of sanatorium treatment, to find occupation in an environment, and under a scheme of management, which secures a continuance of the sanatorium regimen. (4) That domiciliary treatment, especially domiciliary visitation, is not fulfilling the expectations that were entertained of it by those responsible for its introduction.

With reference to the first of these defects, I may point out that during the past two years we have been enabled in Nottingham to make an experiment in the housing of advanced cases of both sexes at our city sanatorium. In the early part of 1915, at the request of the Local Government Board, the War Office, and the local Poor Law Guardians, we consented to admit all such cases then in the Union Infirmary, in order to allow of the use of the latter as a military hospital, and this section of our sanatorium has lately become so popular that many insured patients (several discharged sailors and soldiers among them), after their term of residence as insured persons, have applied for admission among the advanced patients in order to prolong their stay. If suitable homes or hospitals were provided in future for advanced naval, military, and other cases, in the districts to which such cases belong, I have no doubt they would be similarly appreciated. Defects indicated under paragraphs (2) and (3) require no exegesis; they speak for themselves. With regard to the existing defects in domiciliary treatment (No. 4), these will probably be remedied by the appointment of special visiting medical practitioners or other suitable officers.

FROM H. HYSLOP THOMSON,

M.D., D.P.H.,

Medical Officer of Health for the County of Hertfordshire.

A twofold influence is exercised by military service on pulmonary tuberculosis. While the conditions inseparable from active service abroad tend to reactivate the disease in soldiers with latent tuberculous foci or to induce an entirely fresh infection, the open-air life, physical exercise and ordered routine of military training in this country undoubtedly exercise a beneficial effect on the health of soldiers who have latent pulmonary tuberculosis, or who, from inheritance or other causes, are predisposed to the disease. In the case of munition workers, although much is being done to safeguard their health, the conditions associated with their employment are such that an increase in the incidence of pulmonary tuberculosis amongst them is to be looked for. Under such circumstances it is highly desirable that the present position with regard to the treatment of tuberculosis should be carefully reconsidered, and, if necessary, that the scheme for the treatment of this disease should be supplemented so as adequately to meet the requirements which have arisen, or may arise, in consequence of the war.

Any scheme which has as its aim the efficient treatment of all cases of pulmonary tuberculosis must include: (*a*) facilities for immediate and appropriate treatment irrespective of type; and (*b*) assistance to maintain arrest and economic cure when such have been secured. The first essential is the provision of efficient hospital treatment for all cases characterized by acute onset or advanced phase. Such treatment is especially called for in the case of discharged soldiers, in many of whom the disease is acute. By hospital treatment is meant, not merely the provision of an institution with beds, but the service of skilled medical treatment, efficient nursing, and up-to-date hospital administration. Such treatment, including as it should pulmonary fixation by induced pneumothorax combined with antiseptic measures, will undoubtedly save a considerable percentage of cases of unilateral disease characterized by acute onset. Experience during the last few years has clearly demonstrated that the second link in the scheme of treatment next to the dispensary system should be the hospital and not the sanatorium; this latter should constitute the third link. In the absence of adequate hospital treatment, a gap exists which seriously impairs the value of sanatorium treatment, owing to the admission of unsuitable cases and the absence of that interchange of cases between hospital and sanatorium which is so essential to the successful treatment of pulmonary tuberculosis according to type and stage.

A period of sanatorium treatment for certain types of the disease is essential if the best results are to be obtained, but the view which is still popularly held, that a period of thirteen weeks' residence in a sanatorium will secure permanent arrest and economic cure, must be discarded. Except for absolutely unavoidable reasons, no patient with evidence of active disease, more especially if tubercle bacilli are present in the sputum, should be discharged from a sanatorium after a few months' residence unless it be for the purpose of transference to hospital; and this rule is especially applicable in the case of war and munition workers in whom the disease has developed in consequence of strain and effort directly associated with the war.

The weak point in the present system of sanatorium treatment is that, while it takes stock of the immediate requirements of the tuberculous patient, it offers no facilities for maintaining arrest and economic cure when such have been obtained. Discharge from the sanatorium at the present time constitutes so sharp a break in the ordered routine and conditions of the patient's life that a relapse too frequently follows, notwithstanding dispensary supervision and efforts at after-care. Unhealthy home conditions, unemployment with its consequent insufficiency of food, unsuitable occupation, and mental worry and anxiety, are incompatible with a continuance of the beneficial result obtained in the sanatorium. No able-bodied tuberculous patient when he leaves the sanatorium should for long be out of employment. In reviewing the conditions which militate against the permanency of arrest in tuberculosis, one must give a foremost place to unemployment and unsuitable and injurious occupations. The question of unemployment should therefore be intimately linked with sanatorium treatment throughout its whole course. The patient from the office, the warehouse, and the workshop, should be instructed in the sanatorium in outdoor or hygienic occupations, experience in which will subsequently prove of practical value to him in securing suitable work. To meet the requirements of the sanatorium patient with regard to future employment, it is necessary, therefore, that the modern sanatorium should be so arranged as to constitute a combined sanatorium and industrial colony, while the length of residence should depend, not on any prescribed period of time, but on the pulmonary condition of the patient and on his fitness and capacity for undertaking a suitable occupation. For the purpose of assisting the able-bodied tuberculous patient to secure suitable employment, present efforts require to be further amplified by the institution of an official employment and after-care bureau, while help in securing improved domiciliary conditions is also urgently required. The aim of such a scheme would be to draft the patient to a suitable occupation on leaving the sanatorium, or to offer him facilities for immediate emigration. By this

means the emigration of such cases which has occurred, and will continue to occur, would be officialized to the benefit of all concerned. Experience has shown that in suitable cases immediate emigration to a country with a less humid climate, following a course of successful sanatorium treatment, results, with few exceptions, in permanent arrest of the disease. But before emigrating or undertaking the more arduous outdoor occupations, the patient would be required to pass a somewhat rigid test. This test should, generally speaking, include: (*a*) the absence of tubercle bacilli in the sputum; (*b*) normal temperature under the condition of manual labour obtaining in an industrial sanatorium; (*c*) absence of crepitations indicative of active disease; and (*d*) absence of tendency to hæmoptysis.

To recapitulate, it would appear desirable, in order to meet present and future requirements, that the treatment of cases of pulmonary tuberculosis should include the following: (1) The observation and treatment of all doubtful cases at the dispensary, so as to secure for definite cases of pulmonary tuberculosis a longer period of residence in the sanatorium; (2) the provision of adequate hospital treatment so as to obviate the admission of febrile or advanced cases to the sanatorium; (3) the development of the sanatorium along the lines of an industrial institution with a view to increasing the duration of treatment and to provide facilities for instruction in suitable outdoor occupations; (4) the institution of an employment and after-care bureau for the assistance of patients when discharged from the sanatorium. By such means the patient will secure the form of treatment best suited for the type of disease from which he suffers, while *pari passu* with the gradual restoration to health, in the case of those who respond successfully to treatment, such instruction and assistance will be given as will enable the tuberculous patient to regain that position which will entitle him to be regarded once more as a useful citizen of the Empire.

FROM HORACE WILSON,

M.D., B.S. (LOND.), D.P.H.,

Tuberculosis Officer to the Borough of Southwark; Honorary Demonstrator in Hygiene and Bacteriology, London University.

The question of tuberculosis among combatants and war-workers is, perhaps, brought more under the notice of a tuberculosis dispensary than any other institution, and the facts elicited on consideration of the question are interesting and, perhaps, rather unexpected. As the Borough of Southwark has contributed a large number of men to the forces, and the district contains, not only a large number of factories, but supplies a great many workers of both sexes to Woolwich and

other large centres, the opportunity for observation has been unusually extensive. During the first rush of recruiting a large number of men already infected with tuberculosis joined the ranks, and they could be divided into several classes : (1) Those who joined from pure patriotism ; (2) those, chiefly early cases, who thought the open life would be as good as a sanatorium ; (3) a few fairly marked cases who would as soon be killed facing the enemy as die a lingering death at home ; and (4) some advanced cases who realized that if they died on active service their wives would receive a pension—which they deemed a desirable form of insurance. These men joined up fully aware of their complaint, but by suppressing facts and trusting to the rush, successfully evaded the examining medical officers. Several had, to my knowledge, already been invalided from the army with tuberculosis. These broke down at once, and were invalided a second time, many dying soon afterwards. Cases like these cause infection in others, but so far more of our cases have joined up already suffering than fresh cases have returned, in spite of war conditions and exposure. Many probably have been killed in the course of the war. Admittedly exposure also without infection will not produce tuberculosis, and the conclusion is that the more stringent measures now adopted on joining up will largely prevent multiplication of cases.

As regards war-workers, many of our cases of both sexes, but particularly the women, have improved in health and condition. The increased wage has meant better food, more comparative luxuries, more necessaries, perhaps even the rent of an extra room or the purchase of an extra bed or cot for the home. The better wage has more than compensated the extra cost of living, and our experience is that the majority of the workers are clever and thrifty in expending the household money, and not the helpless creatures many of our social reformers would have us believe. The factories are, generally speaking, well ventilated, the hours reasonable, and the mealtimes regular. There is no time for moping and introspection ; financial worry—perhaps the most depressing factor in life—is removed, and the cases tend to improve in health and spirits. As regards infection, the war-worker is living and working under improved conditions, and is less likely to spread the disease in a healthy factory than in the stuffy rooms of a small tenement or airless court, whereas the combatants are living under conditions of hardship, privation, and exposure. In conclusion, we have found the war conditions of actual benefit in tuberculosis. They have brought to light unsuspected cases, improved the conditions of many others, weeded out the unfit, and relieved congestion and overcrowding, while as regards the future the improved physique of the men and stamina of the women will provide a race less likely to prove a breeding-ground for the tubercle bacillus.

FROM HENRY WILSON McCONNEL,

M.A., M.B., M.R.C.S.,

Member of Council of National Association for the Prevention of Tuberculosis, and Hon. Secretary of Kelling Sanatorium, Norfolk.

In the early part of the war a large number of men, who had been patients at sanatoria and sufferers from tuberculosis, were enlisted into the army. This no doubt was due (*a*) to overpressure of work among the R.A.M.C. who passed them as medically fit, (*b*) to no effort being made to ascertain whether any case had a history of previous tuberculous disease. It is interesting to note how well a considerable number of these tuberculous subjects have kept while on service, and especially so cases where an interval of at least a year had elapsed since the completion of treatment at the sanatorium. In the aggregate, however, a large number of cases have broken down under the stress and strain of military life. It is clear that those cases in which the disease has been initiated or reawakened by war service deserve adequate compensation and pension from the country which they have sought to serve, just as any other combatant damaged in the adventure of war demands, expects, and receives. Moreover, as the treatment of tuberculosis is generally successful in proportion to the earliness of its commencement, it is essential that there should be no delay in granting this pension, a temporary grant possibly being made at once till the permanent pension is settled. Arrangements, indeed, are now made that the tuberculous soldier on discharge from the army is to be sent to a sanatorium; but this course is often useless, if at the same time his separation allowance is stopped, and no compensatory grant is made to enable him to keep his family. It is doubly necessary that a money grant of some sort should be made at once on discharge of every tuberculous subject. As regards treatment and after-care, it would seem best to make use of, and where necessary to amplify, the existing machinery, rather than to go to the expense and uncertainty of creating fresh machinery. The tuberculous soldiers are for the most part insured cases, and should be drafted on discharge without delay to their own neighbourhood, and there dealt with, if insured, as insured cases, and if uninsured, in the way that uninsured are dealt with in their particular district. This would not, of course, prevent suitable cases being sent direct from the military hospital to sanatoria arranged for by the local authority. Every County Council and Borough Council has an anti-tuberculosis scheme, either in full work, in partial work, on paper, or under consideration. Practically all County Councils and many Borough Councils have agencies in full work, though the complete development of others has been checked by

the outbreak of war. This development should now be encouraged, and an extra monetary grant made if necessary for this purpose. There need be no hesitation about this course, for it will be found far cheaper in the long run to give it than by doing nothing to allow cases to drift, as they otherwise must, into the workhouse and so on to the rates; moreover, soldiers and sailors require better from us than this. The full tuberculosis scheme, as approved by the Local Government Board, should include: (*a*) Sanatorium treatment for early and suitable cases; (*b*) dispensary treatment where necessary; (*c*) adequate hospital management for advanced cases; (*d*) appropriate hospital residence and skilled supervision for surgical cases; (*e*) the help of a strong and representative care or after-care committee which shall co-ordinate both statutory and voluntary efforts in the neighbourhood. Such a committee will—(1) Advise and assist cases; (2) see that hygienic rules as recommended are carried out; (3) assist in improving the housing accommodation and home conditions of each patient; (4) endeavour to find suitable employment for arrested cases, and render all such aid as is humanly possible to enable the stricken to meet the severe handicap laid on him by his disease. (*f*) If possible, too, either in connection with the sanatorium or the dispensary, educational centres should be established. This may take the form of a farm colony, a community garden, or a handicraft school. Some such centres should be started in every neighbourhood, to train suitable cases who are recommended to change their former occupations. The great principle to guide action is to allow each locality to look after its own consumptive soldiers where they are known, and where there is local interest.

FROM CUTHBERT G. WELCH,

M.D. (LOND.), D.P.H. (OXON.),

Tuberculosis Officer to the Bedfordshire County Council.

There still prevails a marked tendency to place too great insistence on the advantages of sanatorium treatment in early and subacute cases of pulmonary tuberculosis and to neglect the provision of adequate hospital accommodation for acute and advanced cases of tuberculous disease. Valuable as sanatorium treatment undoubtedly is, it must be remembered that the period of thirteen weeks, which is commonly the length of stay granted by Insurance Committees, is far too short to allow of any reasonable expectation that arrest of the disease will be achieved. The benefit obtained is largely an educational one, and as such is extremely valuable; and where the patient is able to continue to have good food and live under healthy conditions on returning

home excellent results are often attained. Unfortunately, however, the financial conditions of many insured persons are such that immediately after their discharge from the sanatorium they are obliged to return to full work, and frequently the improvement which they had made is rapidly lost under the combined influence of the tax placed upon them by long hours of hard work together with an insufficient or unsuitable dietary. I am strongly of opinion that the establishment of open-air residential schools for children suffering from every form of tuberculosis, with hospital accommodation where necessary for acute cases, should be considerably extended. Tuberculin has not taken the prominent place in the after-treatment of patients discharged from sanatoria such as many anticipated and some advocated, for it has been shown that its administration to out-patients is far too hazardous to be employed except in a few carefully selected cases, and where there are exceptional opportunities for accurately observing the effect of each dose. In my experience, very few patients can be trusted to keep an accurate record of their temperatures, without which no one would venture to administer tuberculin. As public health measures for combating tuberculosis, I would advocate a greater concentration on the provision of institutional treatment for children and the provision of hospitals for advanced cases. We must work also for better housing conditions for the workers, not only in urban centres, but also in rural areas, and endeavour to secure a pure milk supply for the community.

# ORIGINAL ARTICLES.

## THE GRANULES OF THE TUBERCLE BACILLUS.

By JOHN SORLEY,
M.A., M.D., D.P.H.,
Medical Superintendent, Grosvenor Sanatorium, Kennington, Kent.

THIS paper does not profess to be a comprehensive account of the granular forms of the tubercle bacillus, around which a vast literature has of recent years grown, but only to summarize some points of interest and importance in regard to these.

### Staining of the Granules.

The tubercle bacillus is an organism which shows certain irregularities of staining, as was first pointed out by Koch, who considered the clear unstained areas so frequently seen to be spores. These unstained areas, as well as others which appear deeply stained, can be shown very readily by the ordinary use of carbol-fuchsin or by the Koch-Ehrlich method of employing anilin water gentian violet. Frequently also one can observe that certain portions of the bacillus, when stained by fuchsin, retain the colour better than others, even where one is not able to demonstrate definite unstained areas. Thus one may find the poles of the bacillus more deeply stained than the rest of the organism, and scattered more or less irregularly throughout the bacillus other deeply stained points.

In order to bring out these deeply stained points still more clearly, Arloing and Biot proceed thus. After staining with carbol-fuchsin in the usual way, they decolorize very completely with 25 per cent. nitric acid, followed by absolute alcohol, and then flooding the slide with pure formol for some few minutes. Stained in this way the bacilli show, according to these observers, deeply stained areas which they call granulations, the intergranular protoplasm being less intensely stained than the granulations. Some of the bacilli resemble little chains, the constituent grains of which are separated by clear spaces, while certain of them show polar granulations, though relatively rarely, and these are generally larger and more intensely stained than the granulations of the bacillary body properly so called.

Spengler in his well-known method employs in succession carbol-

fuchsin, picric acid (in order to fix the fuchsin), iodine, and osmic acid vapour. He finds the bacilli stained more or less deeply red by the fuchsin, and the granules red, black-red, or deep black, and that the latter may be present without a red staining bacillary body.

Another method for the demonstration of the granules in the tubercle bacillus may be alluded to here—that is, the silver reduction methods of Yamamoto and von Betegh. Neither process, in my hands, has proved satisfactory.

Of all the many methods and modifications of methods which I have tried, I find Gram, or some modification of Gram, in association with carbol-fuchsin gives the best and most consistent results. It is, in my opinion, not sufficient to use Gram alone, but to use it in conjunction with Ziehl-Neelsen. One of the best-known Gram stains for the particular purpose with which I am dealing is that of Much, who uses methyl violet, and states that his particular process is able to demonstrate organisms of the following types, which are not acid-fast —viz., deeply stained blue-black rods, isolated blue-black granules, groups of granules, and granular rods. Weiss combines Much's stain with carbol-fuchsin in one solution and stains in the cold. He confirms Much's results. Herman uses crystal violet instead of methyl violet, and claims that the stain is very much more powerful than Much's, in that it often shows deeply stained rods where Much's only shows granules.

Fontes, who originally devised his stain for the purpose of differentiating between true and pseudo-tubercle bacilli, stains first with carbol-fuchsin and then with Herman's crystal violet, and this process, modified in certain respects, is that which I recommend and use. The following are the details of my method (or the method I use). Materials required: Carbol-fuchsin, Herman's solution of crystal violet (3 per cent. in 95 per cent. alcohol, one part; 1 per cent. ammonium carbonate, three parts; the addition being made just before use and well mixed), tinctura iodis mitis (B.P.) replacing the ordinary Lugol's solution of iodine, and methylated spirit instead of the much more expensive acetone-alcohol. Flasks and slides require special treatment, for reasons I shall afterwards mention. The former should be thoroughly washed out with hot water and soda, filled with 5 per cent. carbolic and allowed to remain overnight, the contents being simply poured out without rinsing just before the patient expectorates. The sputum examined should be that expectorated first thing in the morning, before the patient has either eaten or smoked, and his mouth should be washed out several times with bicarbonate of soda and water. The slides should be treated in succession (and this applies equally to slides which have never been used before) with hot soda, fuming hydrochloric acid, and then kept in ether-alcohol till required, when they should be wiped dry

with an old, well-washed, fat-free cloth. The following is the order of technique: (1) A fine film is made with as little manipulation as possible, in order to avoid distortion of the organism, and allowed to dry spontaneously and fixed by 1 per cent. chromic acid or by passing three times very cautiously through the flame. (2) Stain with carbol-fuchsin in the usual way. (3) If the film be thin, decolorization at this stage is unnecessary, otherwise weak (5 to 7 per cent.) mineral acid, or simply hot water for a minute or two as advised by Kaufmann, will be sufficient. The use of strong mineral acid should be avoided. (4) Flood with crystal violet and allow to remain for a couple of minutes, wash off, and follow by tinctura iodis mitis, which should act for about thirty seconds. (5) The slide is then washed very thoroughly in water, in order to remove as much of the iodine as possible, since the presence of the latter impairs the permanency of the preparation. (6) Differentiate with methylated spirit, renewing as often as necessary until the film is decolorized, and then counterstain with weak (5 per cent.) methylene blue for five seconds only, as stronger solutions may replace the carbol-fuchsin in the bacilli and render the latter indistinguishable. (7) Wash, dry between filter-paper, and examine directly with an oil-immersion lens, using artificial illumination, an immersed substage condenser, and a magnification up to 1,500.

Stained by this method the bacilli appear as homogeneous red rods, in which, except for the granules, no structure, network or otherwise, can be distinguished. The granulations appear of a very dark red or black, the latter particularly when polar in position. Isolated granules or rows of reddish granules are very exceptionally seen, and may be accounted for in some instances at least by defects in the process of staining.

### Types of Bacilli and Granules.

These types of bacilli and the forms of their granules are of so bewildering a variety when found in the sputum as to make any exact description or classification at present impossible.

Spengler of Davos, whose authority on all matters pertaining to tuberculosis is unquestioned, finds that three types of bacilli can be distinguished—viz., (1) the humano-brevis (of Koch), (2) humano-longus (of Spengler), and (3) the true bovine type, differing in staining reactions, in cultural characteristics, in virulence, and in other ways. In distinguishing them stress is laid by Spengler on staining the sheath of the bacillus or outer limiting membrane, the existence of which, nevertheless, is still a matter of doubt and controversy. Although not always demonstrable, its existence may be presumed in every case. It is probable, also, that this sheath continues to form the outer layer of

the granules, as certain types of bacilli are only explicable on the assumption that such is the case.

Without attempting to discuss Spengler's classification in detail, it may be sufficient to state here that, roughly, two types of bacilli, one long and slender, and the other short and thick, are met with. Early cultures of human, bovine, and avian tubercle, as well as many of the clumps observed in sputum, show the bacilli to be usually very short in type, arranged in characteristic parallel disposition, with well-marked black and spherical granulations situated at the poles of the bacillus. These appear to be young bacilli, and only occasionally do we meet with granulations in them, occupying the substance of the bacillus. Wolbach and Ernst have noted this parallel arrangement of the bacilli in early stages of cultural growth, and Miehe ascribes it to a sort of "gliding" movement of the bacilli during their development, whereby they slip over one another by virtue of a slight bending of the extremities of the bacilli and, remaining closely adherent, so arrange themselves in parallel masses.

As development proceeds and the bacillus grows longer, other granulations begin to make their appearance, first seen as a faint, hardly discernible shadowing in the rod, but gradually increasing both in size and number till certain of them become spherical, lose their somewhat indefinite reddish colour, and become black like the typical polar granulations just mentioned. At this stage careful observation will show that many of these larger and blacker granulations are in reality double, as if, after having attained a certain size, they had undergone a process of division. Thus an apparently single long bacillus with many granulations may consist of a number of short, separate bacilli, each with its polar granulations, resulting from the division of the medullary granulations and a simultaneous increase in length of the red-staining material between.

In trying to interpret the appearances met with, it is of importance to remember the spacial arrangement of the bacilli, the fact that they do not all lie in the same superficial plane. Non-recognition of this fact is accountable, in my opinion, for many mistakes in interpretation —*e.g.*, unusual size and shape of the granulations, abnormal length of certain bacilli—and for the quite extraordinary number of granulations which have been seen in a single bacillus.

Some bacilli appear to have no granulations, but this may be due, in some instances at least, to defective staining. Other bacilli may show only one terminal granule, the "drumstick" form, and not infrequently the polar granule is only approximately so, a shorter or longer protrusion of red-staining material appearing beyond the granule, tapering away vaguely and indistinctly. These "continuation" forms seem to support Kirchenstein's view that the sheath of the bacillus is continued

round the granule to form its outer covering. According to Kirchenstein, such protrusion may take place from both sides of a granule, giving the appearance of a single bacillus with one central granule. Here again in time division of the central granule may be observed, giving rise to two distinct and separate drumstick bacilli, with their granules in close approximation. The granulations at the extremities of the bacillus also appear to undergo division, intermediate red-staining substance being sometimes seen, sometimes not.

Bacilli frequently cross each other at a granule, giving an erroneous impression of branching, though true branching also occurs occasionally. Two or more bacilli may sometimes be observed arising from one granule. I have seen as many as five radiating like the spokes of a wheel from a large central axis granule. Although this appearance has been observed by Wolbach and Ernst in certain cultures, I am inclined to think that the large central granule is often really multiple.

One of the reasons for my advocacy of the modified Fontes' stain is the very sharp manner in which it picks out the structure of the individual bacilli and their embedded granules. No other process of the many I have used seems to give quite the same delicacy and clearness, but it must be understood that the description I have given is that which, on the whole, is based on this process. Other modifications give perhaps different results, and this will explain the varying accounts which one meets with in authors.

### Chemical Constitution of the Granules.

According to the "scheme" elaborated by Much, the tubercle bacillus contains an albuminoid group and a mixture of fatty substances. The former contains a toxin and albumin, the latter a neutral fat, a fatty alcohol, and a fatty acid. The intergranular substance corresponds to the fatty acid constituent, whereas the granules seem ultimately to contain an albuminous substance and a fatty substance apparently of the nature of a neutral fat. It is not the purpose of this paper to carry this question further.

### The Function of the Granules.

From what I have already stated, it will be apparent that I consider that the granules play an active part in the reproductive life of the bacillus, thereby excluding theories that they are artifacts, the result of plasmolytic processes, metachromatic granules, reserves of foodstuffs, and the like.

Reproduction seems to me to take place thus: The young bacillus, with its characteristic polar granulations, increases in length, and in its substance appear other granulations, in which, sooner or later, dimpling occurs, with the formation of a fine transverse line of division until

complete separation into two granules occurs. Division goes on more or less rapidly through the formation and maturation of the granules, with the result that filamentous forms of the organism appear and shorter or longer individual bacilli develop, according to the extent of differentiation of the intergranular protoplasm.

The method of reproduction of the bacillus by means of continuation or protrusion forms, or by division of the polar granules, seems to occur much less frequently, in the sputum at any rate, and the other may, therefore, be considered the more normal process. I have some reason to believe, as will be stated presently, that there may be a certain clinical correspondence with these two methods of reproduction.

Two other theories, however, require to be shortly discussed.

1. *That the Granules are Spores.*—The chief exponent of this theory, which is widely held, is von Schrön, who, in 1887, described the tubercle bacillus in an early stage as a torula-chain, the granules of which recede from one another during development, the intercellular substance of the bacillus being a product of secretion of the granules. By a process of regressive metamorphosis the granules are set free as spores, which enlarge to become mother-spores, possessing a capsule and granular contents, the latter becoming daughter-spores, which burst the capsule and leave the mother-spores either separate or as a torula-chain (the young bacillus).

There are many objections to the spore theory, apart from the criticism that no other author seems to have seen these reproductive processes as described by von Schrön. They may be summarized as follows: (*a*) The sequence of events as seen in the bacilli is only explicable, so far as my own observations go, on the assumption that the young bacilli are not a chain, but simple organisms with characteristic polar granulations. (*b*) Spores are generally single, whereas, in the tubercle bacillus, the granulations are multiple, though the number of seventeen, as given by one author, is probably an error of observation, for reasons given. (*c*) They do not appear to stain by the usual spore-staining methods. (*d*) They do not germinate like true spores. (*e*) The conditions favourable to their production in the tubercle bacillus are not necessarily unfavourable to the growth of the bacilli. Wherry, for example, found that growth on certain media was twice as extensive as growth on certain other media, and that the bacilli showed numerous intensely staining granules. This seems to indicate at least that if the conditions were favourable for the production of the granular forms of the bacilli, they, at the same time, were not unfavourable for the growth of the bacilli themselves. (*f*) Their appearance in young, rapidly growing cultures of the tubercle bacillus is also against them being spores. Any theory which assumes these bodies to be spores must, I take it, maintain at the same time that their formation occurs at a late

stage of bacillary existence and when decay has set in, for "the mission of the spore is to preserve the species when the conditions otherwise are unfavourable for this purpose."

2. *That the Granules are Sporoids—i.e.*, bodies which possess the function but not necessarily the resisting power of the classical spore. This is Spengler's theory as developed so brilliantly by Kirchenstein. The evidence as to the resistance of the granules to the action of chemical and other agents is rather contradictory, but, on the whole, it may be said that, though less resistant than spores indubitably known to be such, they are the most resistant part of the bacillus. It is essential to this theory to show degeneration of the substance of the bacillus, in order that the process of sporoid formation should then have an opportunity of coming into play. Hence the importance attached to staining processes, which, in Spengler and Kirchenstein's views, demonstrate such degeneration. Step by step with this degeneration of the sheath and substance of the bacillus there goes formation of the granulations, at this stage called growing sporoids. These are finally thrown off free into the surrounding medium, either singly or in rows, which may or may not still show a connecting thread of red-staining material, or aggregated into larger or smaller masses, the "splitter" granules of Spengler. In a favourable case of tuberculosis the "splitter" undergo further disintegration and ultimately disappear. The sputum is not to be deemed free from the infective agent, unless, in addition to the absence of acid-fast forms of the bacillus, splitter are no longer to be demonstrated, for, under certain conditions, the latter may undergo a progressive or developmental metamorphosis (germinating sporoids), instead of a regressive change, and give rise to young and very minute bacilli, which in turn mature and in their decay develop growing sporoids, and so complete the life-cycle of the organism.

To some extent the same objections as apply against the conception that these bodies are spores also apply here, and, in my opinion, the theory does not explain so satisfactorily the appearances met with in the sputum. In spite of the authority of Spengler's name and the wealth of detail with which Kirchenstein has enriched his researches, it cannot be admitted that sporoids exist as such, and confirmation will have to come before the theory can be accepted. One difficulty which lies in the way of its acceptance is the stress which is laid on the element of degeneration of the organisms. I shall, therefore, discuss the question of degeneration briefly.

**Degenerative Changes in the Tubercle Bacillus.**

The commonly accepted signs of degeneration of the tubercle bacillus are the loss of acid-fast material and the failure of the organism to retain the red colour when carbol-fuchsin is used; segmentation and vacuolation of the bacillus; and failure of the granulations

to retain Gram. One is thus left with the reddish debris of bacilli and isolated granules in all stages of disintegration.

The effects of phagocytosis on the bacilli and the granules have also been noted as occurring in the sputum, in the leucocytes of animals which show a great natural resistance to tubercle, and in artificially immunized animals.

So far as the sputum is concerned the signs of degeneration of a bacillus enclosed by a phagocyte are similar to those described in bacilli lying outside, though there does not appear to be any quite infallible indication of the bacillus being inside the cell, whether it be the evidence of degeneration referred to, the presence of an unstained halo around the organism, or yet peripheral bulging of the chromatin threads of the nucleus of the cell. When it seems clear, however, that the bacillus is really engulfed, it does not always seem very evident that it is the bacillus which has suffered. As Löwenstein has put it, the appearance of the bacilli "does not seem to warrant the conclusion that they have suffered any damage therefrom." On the contrary, from the frequency with which clumps of young bacilli with well-stained characteristic polar granulations can be observed in the leucocytes, it would appear that they have found the phagocyte a not unfavourable medium for reproduction, suggesting that, if liberation of the bacilli were to take place, they would be in a condition to do further damage.

In regard to the question of the phagocytosis of the bacilli observed in animals naturally highly immune, Bergel has recently described certain observations of some interest. For his experiments he selected the white mouse, on account of the great resistance it shows to tubercle. Pure cultures were injected into the abdominal cavity, the exudate, especially the mononuclear white blood-corpuscles, being the medium through which the disintegration of the bacilli was studied. Briefly stated, his results are as follow: The tubercle bacillus is a slender rod, strongly acid and alcohol-fast, and staining uniformly deep red by Ziehl-Neelsen. This is due to a waxy mantle enveloping the whole bacillus. Beneath that is a substance staining dull red, with dark red staining granules embedded in it. This forms the outer layer of the granules, and beneath it is a still deeper layer staining violet-black by Much's stain, and beneath this is a last substance which only stains by methylene blue, the counterstain, the appearance being that of a fine rod with blue, often projecting, granules,

Bergel's theory has at least the merit of settling the protracted and somewhat acrimonious controversy between Much and Spengler as to the identity of their respective granules, for, according to Bergel, the splitter are not identical with the granules of Much, but are the acid-fast bacillary parts or separate acid-fast granules staining red with

carbol-fuchsin, whereas the granules of Much are a further stage in the process of disintegration, and do not represent any special type of the tubercle bacillus. That part of the bacillus which is only stainable by methylene blue represents the last stage of the bacillus which can be demonstrated before complete dissolution. So that, if the splitter be indeed merely the first stage of degeneration of the bacillus, there does not seem to be much ground for the occurrence of a progressive or developmental metamorphosis into young bacilli and the commencement of a new cycle of life for the granules, and still less for the development of true acid-fast forms from the granules which Much asserts may, under favourable conditions, take place.

Moreover, if the Gram-positive elements of the bacillus in the sputum are indeed an advanced stage of decay, it seems quite obvious that we shall have to revise all our ideas of what are normal and what degenerated bacilli, for my own observations all go to show that the occurrence of reddish granules either singly, in masses, or in streptococcus-like chains is exceptional, and that the Gram-staining elements are always present under normal conditions. It may be, however, that these appearances are the result of the destructive effects of complex staining processes, whereby the sheath of the bacillus and the outer layers of the granules are stripped by reason of the inherent delicacy of their structure or chemical constitution. For the present I prefer to consider the Gram-positiveness of the granules rather as evidence of the normal state of the bacillus and an index of its reproductive activity.

As to the evidence of degeneration of the bacilli met with in artificially immunized animals, Marzagalli and Sciallero describe the process as beginning with the formation of vacuoles in the body of the bacillus, which then acquires a streptococcus-like form. Such stage may persist for long or may go on to ultimate disappearance, whereby the granules may preserve or lose entirely their specific staining properties. These changes differ very materially from the changes described by Bergel, but correspond with those already given as occurring in the sputum.

Before these various appearances which denote degeneration in the bacilli are to be accepted at their face value, certain fallacies both in staining and in interpretation have to be disposed of. For nothing is more certain than that all the appearances stated to be characteristic of degenerative processes in the bacilli and granules can be simulated under purely artificial conditions. And it has not infrequently happened that, after a series of slides have been stained showing all the signs of degeneration which have been given above, I have been able to obtain one, stained with every possible precaution, perfect in all respects. The moral of this is that it is hardly wise to accept the

presence of reddish granules, either disjoined or in streptococcus-like chains, or segmentation of the bacillus, or other similar abnormality, as indubitable evidence of degeneration in the organism, unless found in a series of slides after all sources of fallacy are excluded. The following points deserve special consideration :

1. The influence of powerful reagents in a complex staining process must be excluded. Although the evidence is somewhat contradictory, the waxy material of which the tubercle bacillus is composed seems to be very resistant to both acids and alkalies. On the other hand, Friis-Möller has reported a case of atypical tubercle bacilli where treatment with antiformin entirely destroyed the organisms. Much, as the result of experiments carried out by him, found that, by heating in a sterilizer, the tubercle bacillus disappeared and only the Gram-staining granules were left, and that the same result followed the prolonged action of organic acids. Spengler states that by too strongly heating the carbol-fuchsin there is produced a partial solution of the waxy substance of the bacillus, the result being decreased staining capacity and easier decolorization. Voltolini considered the granules to be merely particles of coagulated albumin produced by the strong mineral acid employed. It is not necessary to labour this matter further. It need only be said that, apart from genuine degenerative processes in the bacillus produced under natural conditions, such changes may be caused by artificial conditions present in staining. In this connection it must also be borne in mind that carbol-fuchsin and other stains employed are regressive stains—*i.e.*, stains which depend for their success on over-staining, with subsequent differentiation. And as heat, strong acids, alcohol, and other reagents, are used, and, as ordinarily used, are not checked at any stage of the process, there is no wonder that, in the result, appearances should be produced that in many respects resemble those which are described as typical of degeneration.

2. The presence of greasy matter either on the slide or in the sputum is a powerful deterrent to good staining, and that is why the precautions already mentioned should always be taken to insure its absence in both cases. Not only in using Gram are these precautions necessary, but particularly so when using osmic acid.

3. The occurrence of large numbers of secondary organisms in a sputum has occasionally a bad effect on the staining of the tubercle bacillus, due perhaps to mere mechanical interference with the action of the stain, or, possibly, to some chemical influence arising from the growth in the same medium of different organisms. The presence of a phagocyte may also be a mechanical obstacle to the penetration of the stain, just as a stray fibre of cloth or overlying bacilli may be.

To sum up, the evidence of degeneration of the tubercle bacillus in the sputum, after all due allowance has been made for the causes of

fallacy to which I have alluded, are neither so clear nor so numerous as at first sight one may be tempted to believe. Nor are they so consistently present as to enable us to draw any very exact clinical deduction therefrom, and so far as my observations have gone, it would appear that a real, not apparent, diminution of the numbers of bacilli from the sputum may be caused, less by an increased death-rate amongst the organisms—*i.e.*, to degenerative and disintegrative processes—than to a decreased birth-rate, arising from some condition of the medium in which the bacilli are growing which is inimical to their reproductive activity. For, however few the bacilli in the sputum, even if only a single bacillus be met with on a slide, they are usually, if not always, typical organisms with characteristic granulations, and unaccompanied by the relics of their less fortunate fellows.

**On the Independent Existence of the Granules.**

After due allowance has been made for all causes of defective staining and mistaken interpretation, there remain cases where the bacilli, or, it may be, certain individual bacilli, manifest true degenerative changes, whether they be interpreted according to the usual opinion or according to the view of Bergel. These are marked by loss of bacillary substance and the more or less evident isolation of the granules. The point of interest and importance here is whether or not the isolated granules have the capacity of regenerating true tubercle bacilli, or are themselves active agents of infection.

Kirchenstein believes that the splitter do possess this capacity, and that they, under given conditions, are able to give rise to young bacilli; but the evidence for this depends largely on the assumption that the splitter granules are of a sporoid nature, and the proof given of this is not very convincing. Nor is it always certain that the masses of granules met with in the sputum, particularly of cases of the disease progressing towards improvement, whose sputa, in the natural course of events, come to lose their typical muco-purulent character and to contain more and more elements derived from the mouth and upper respiratory passages, in which, also, secondary organisms, cocci, and so on, abound, can always be identified as tuberculous in origin.

Much believes that his granules are a distinct form of the tubercle bacillus and exist apart from the acid-fast forms, basing his belief on the specificity of a particular preparation of methyl violet for the granules, and on the fact that, in examining the caseous masses from the lungs of cattle, he was able to show the complete absence of tubercle bacilli therein by the usual methods. These masses, however, when implanted into guinea-pigs, were found by Much to cause typical tuberculosis, and typical bacilli were recoverable in the lesions, capable of being grown upon suitable culture media. Much states that his

particular method of staining is able to demonstrate organisms of the following types which are not acid-fast: Deeply stained blue-black rods; isolated blue-black granules; groups of granules and granular rods. Much's claims are supported by many observers, especially by Weiss, who combines in one solution carbol-fuchsin and methyl violet, and stains in the cold.

On the other hand, Bittrolff and Momose, repeating these experiments on the pus from cold abscesses and tuberculous glands in man, and other tuberculous material from animals, came to the conclusion that no other form of the tubercle bacillus could be demonstrated by Much's method than by carbol-fuchsin. So also Macalister, in a comparison of different staining methods, found that his series of films from sputum did not afford any independent evidence of a type of tubercle bacillus demonstrable by Much's methods which would not be shown more satisfactorily when stained according to Ziehl-Neelsen. Böhm came to a similar conclusion. The latter author also points out very clearly the fallacy underlying Much's and Wirth's experiments, in which, after injecting tuberculous material, where alone granules and no acid-fast forms could be demonstrated, into animals, they obtained a growth of ordinary acid-fast bacilli. Obviously only a very small portion of the material was used and bacilli might easily have been overlooked, sufficient, at least, to have reproduced themselves in the animal.

Further, many observers[1] have found in similar tuberculous material a varying proportion of acid-fast forms, and it is quite probable that a more thorough search and, perhaps, the use of a more efficient stain would have demonstrated them in all.

Much's stain only owes its supposed specificity to its being a modified Gram, and Herman, reinvestigating the whole question after the publication of Much's researches, came to the conclusion that crystal violet has a much stronger affinity for the tubercle bacillus than methyl violet.

The use of antiformin as a means of differential diagnosis between the granules of Much (insoluble) and other cocci and debris (soluble) does not prove anything when a combined stain is used, for there is reason to believe that antiformin may, under certain conditions at least, damage the substance of the bacillus. Moreover, such a stain as that of Gasis, based on the resistance offered by the organism to alkalies, is not nearly so effective a stain as carbol-fuchsin or crystal violet. Macalister (who, it may be remarked, also used antiformin in his experiments), for instance, gives the relative efficiency of Herman's, Much's, and Gasis' stains compared with Ziehl-Neelsen (100) as 100, 96·66, and 69·23 respectively.

[1] See Meader for a very comprehensive bibliography.

Using my own modification of Fontes' stain, I can assert that I have never come across isolated Gram-positive granules that could be considered as tuberculous in origin in the sputum, and, in general, the evidence as to their existence seems to me to be very unconvincing. The granules, in my opinion, are an integral constituent of the living, active bacillus, and if the latter be damaged or destroyed then the former also are affected injuriously. They can only exist in an isolated condition when degeneration has occurred and their reproductive capacity gone; normally they are the index of the vitality of the organism, and their presence is essential to its reproductive activity.

**Clinical Significance of the Investigation.**

Degeneration of the bacilli as shown by the presence of splitter in the sputum is of good omen in Spengler's view, and is a rational deduction from the observed facts. But, so far as the presence of granules in the undegenerated bacillus are concerned, no clear clinical deduction can be drawn. The young tubercle bacilli are not multigranular—*i.e.*, they possess no other than the characteristic polar granules—but as they mature then other granules begin to make their appearance in the substance of the bacillus and form the active agent in its reproduction. But the maturity of the bacillus does not necessarily carry with it either increased virulence of the organism or decreased virulence. The view of Gauss and Schumburg that the granulations in an organism vary with the reaction of the medium in which it is grown, and have nothing to do with virulence, is probably right. It may be noted also that the latter author does not find that the presence and quantity of the granules go hand in hand with the severity of the clinical course of the disease. Others, however, have stated that the multigranular forms are more numerous in the more chronic cases of the disease, in the contents of cavities, and so on. Attempts to enumerate the granules in the bacilli yield very unsatisfactory results, on account of the great difficulty, sometimes the utter impossibility, of distinguishing the individual bacilli. Two such attempts are given below. My notes of the cases taken at the time, however, emphasize

TABLE INDICATING PERCENTAGE OF VARIOUS FORMS OF GRANULES.

| Granules. | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| | Per Cent. | Per Cent. | Per Cent. | Per Cent. | Per Cent. | Per Cent. |
| Case 1: H. D. ... | 2 | 19 | 30 | 26 | 19 | 4 |
| Case 2: E. D. ... | 1 | 67 | 25 | 3 | 4 | 0 |

the probability that many of the apparently single bacilli showing three and four granules are really multiple bacilli with granules in too close approximation to be separated by even the most careful scrutiny.

Thus the proportion of twos ought to be higher and the proportions of the others considerably lower.

H. D., a male, aged 52, showed excellent resisting power, but took his departure from the sanatorium against advice, and broke down within a month. E. D., a female, aged 25, with active and extensive tuberculous disease of lungs, discharged as hopeless, readmitted and still alive ten months after.

I seem to have noted in a few instances, however, a certain correspondence between the appearance in the sputum in predominant numbers of the more abnormal forms which show an intense capacity to take the red stain, continuations and protrusions, and drumstick types of bacilli, and a marked severity of the clinical course of the disease. In one instance death took place shortly after the examination of the sputum was made, and in another an acute exacerbation of the disease led to a very unfavourable prognosis. The patient, a young girl of seventeen, recovered, however, and these types of bacilli were seen to disappear and to be replaced by the more normal types.

It must be confessed, therefore, that in spite of Kirchenstein's brilliant contributions to this subject, it seems at present impossible to draw any very exact correspondence between the granular forms of the tubercle bacillus and the course of the disease. The presence of the granules implies simply that the bacillus is in a state of active reproduction, the presence of interpolar granules that the bacillus has attained a stage of greater or less maturity, and that, whether the bacilli be few or many, the severity of the disease and the prognosis are not necessarily affected thereby; for it is a matter of common clinical observation that a case where the prognosis is good may have many bacilli in the sputum, whereas a case where the prognosis is hopeless or grave may show few or even none at all.

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# A STUDY AND CRITICISM OF THE MORPHOLOGICAL VARIATIONS IN THE NUCLEI OF THE POLYMORPHONUCLEAR NEUTROPHILE LEUCOCYTES IN PULMONARY TUBERCULOSIS.

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The adult mature polymorphonuclear leucocyte measures 10 to 12 $\mu$ in diameter. Its shape is variable, being round or spherical when resting, and, when moving, polymorphous. The cell body is oxyphile in reaction and is filled with granules of various kinds which are scarce in the immediate vicinity of the nucleus, whilst towards the periphery of the cell they are more abundant. The nucleus, with which we are specially concerned, is polymorphous rather than multipartite, and stains dark blue with Leishman's stain owing to its richness in chromatin. The latter may be deposited in almost any shape or form, depending on circumstances which are at present not very well defined. As Da Costa[1] remarks, the nucleus may be "elongated, wreathed, lobulated, horseshoe-shaped, or twisted into designs resembling various letters of the alphabet, such as Z, S, U, or E." By the use of any of the double stains formed by mixing methylene blue and eosin, the nuclear configuration may be made out with clearness as well as with a fair amount of accuracy. The nuclear outline, in normal polymorphs, is well defined in well-stained specimens, and the nuclear substance presents a somewhat mottled appearance, due to the chromatin being condensed at various points of the nucleus.

### Microscopic Technique.

In order to decide in any given case whether a nucleus is polymorphous or polynuclear, one must give special attention not only to the preparation of the films, but also to the focussing of the cells. The usual disposition of the chromatin network is in clumps, connected by bridges of varying degrees of breadth and thickness. In some cases

[1] Da Costa: "Clinical Hæmatology," p. 214. London: 1905.

the clumps can be made out with clearness when the bridges or bridge joining them cannot, and careful focussing will frequently reveal bridges shining through the cytoplasm when they were hidden at the time of examining the clumps. In other cases it is quite impossible to say definitely that a connecting bridge is present, even when the cells are focussed most carefully, and in such cases one is forced to conclude that the nucleus is composed of two or more distinct parts, as the case may be. In the latter case the term " polynuclear " is an apt one. In order to obviate the difficulty of deciding whether a nucleus is or is not divided, Cooke[1] has made the following definition: " If there is any band of nuclear tissue, except this chromatin filament connecting the different parts of a nucleus, the nucleus cannot, for the purposes of the Arneth count, be said to be divided." Such a definition depends for its universal application upon what one understands by the term " chromatin filament." It is obvious that the staining of the specimen, apart altogether from the powers of observation of the examiner, might convert filaments into bridges and *vice versa*.

In 1904 Arneth[2] put the morphology of nuclei on a more firm basis than it had been hitherto. His work has served as a stimulant in many researches on the hæmatology of tuberculosis and of other conditions, and in Germany, and in America particularly, the so-called " Arneth " count may be said to have established itself in the realm of clinical pathology. Arneth's work has been reviewed by Klebs[3] and others in America. Briefly, the neutrophile leucocytes are divided into five classes according to whether the nuclei are composed of one, two, three, four, or five parts. In Class I., the nucleus may be round or may have an indentation in it. Classes II., III., IV., and V., contain cells which have separate chromatin parts—round parts or " loops," as the case may be. Cells with more than five pieces of chromatin composing their nuclei are placed in Class V.

Arneth's method of counting the polymorphs, and the deductions he derives therefrom, have been subjected to strong criticism by Paulicek,[4] Bourmoff and Brugsch,[5] Schilling,[6] and others. Paulicek asserts that the count is of no value either in diagnosis or prognosis, and with this the other observers mentioned agree.

Arneth's belief is that, in its change from the myelocytic form, the nucleus of the polymorph is, firstly, indented, then bent, and at last

[1] Cooke: " Arneth Count." Glasgow: Gilmour and Lawrence, Ltd., 1914.
[2] Arneth: " Die Neutrophilen Leukozyten b. Infektionskrankheiten," *Deut. med. Woch.*, xxx. 54, 1904, and other papers.
[3] Klebs, A. C. and H.: " Hæmatological Studies in Tuberculosis," *Am. Journal Med. Sc.*, cxxxii., p. 538, Phila.; also Nat. Assoc. for Study and Prevention of Tuberculosis: Report of Second Annual Meeting, 1906.
[4] Paulicek: *Folia Hæmatologica*, iv., p. 751, 1907.
[5] Bourmoff and Brugsch: *Zeitschr. f. klin. Med.*, lxiii., p. 489, 1907.
[6] Schilling: *Fol. Hæmat.*, vi., p. 322, 1908.

lobulated, the cells with a single nucleus thereby representing cells of a more youthful type, and the multinucleated cells those of older age. It is certainly the case that the cells with three, four, and five nuclear segments are almost invariably rich in granules, but whether the presence of granules determines the polynuclearity, as Blumenthal[1] suggests, is doubtful. As a result of researches on the opsonic index in acute leukæmia, Parvu and Foy[2] maintain that young forms of leucocytes, such as the mononucleated polymorphs, do not possess any phagocytic power, and are therefore less effective cells in the body defence.

It is to be noted, however, that Brugsch and Schilling dissent from this view, and declare that the degree of segmentation of the nucleus bears no relation whatever to the age of the cell. Neumann[3] believes that the nucleus of the polymorphonuclear leucocyte becomes simpler in form when the cell ceases amœboid movement—a point in agreement with Sherrington,[4] who found that if polymorphs are allowed to quiet down before they are killed, their nuclei usually return to a spherical form. Grüner[5] has shown that the age of the cell in question may be deduced by noting the actual bulk of nuclear matter, the young cells showing thick nuclei, while the older ones have small lobes and long filamentous interconnections, or are more slender than the first-named. In many of the cases of advanced phthisis from which I have taken blood-films, I have noted that the nuclei with one or two segments tend to stain very deeply, and that the outline is not nearly so distinct as in the case of the cells with three or more nuclear lobes. Moreover, there is, as Cooke[6] has suggested, a tendency for the chromatin to project out into the cytoplasm in a most irregular fashion, as if polynuclearity were being attempted. It appears, however, that whatever be the significance of the lobulation of the nuclei, it does not alter appreciably during the active movement of the cell. In other words, knobs or round particles do not become bridges or loops, and the converse is equally true. In proof of this statement may be mentioned the experiments of Millar and Reed,[7] which I have repeated with the same results. The method employed was to scratch the slide with sand-paper and clean thoroughly prior to making the film. The blood was then firmly but slowly drawn across the scratched slide in order to insure that the neutrophile cells would catch on the scratches.

[1] Blumenthal: *Fol. Hæmat.*, vii., p. 297, 1909.
[2] Parvu and Foy: *Tribune Med.*, February 19, 1910.
[3] Neumann: see Grüner, "The Biology of the Blood-Cells," p. 216. Bristol: Wright, 1913.
[4] Sherrington: Proc. Internat. Congress of Physiologists, Liège, 1892.
[5] Grüner, O. C.: "The Biology of the Blood-Cells," p. 214. Bristol: Wright, 1913.
[6] Cooke: "The Nucleus of the Neutrophile Polymorph in Health and Disease," *Journ. Path. and Bact.*, vol. xix., p. 506.
[7] Millar and Reed: *Arch. of Int. Med.*, p. 616, May, 1912.

The phenomenon resulting corresponded accurately with the findings of Millar and Reed, many of the cells being elongated, but the resulting differential count of the nuclei was the same as that obtained from films taken from the same patient, made and stained by the usual method.

During the past decade numerous observers of repute have verified Arneth's work; one and all agree that the counting of the nuclear segments of the polymorphonuclear leucocytes serves as a guide to diagnosis and prognosis in certain diseased conditions, and particularly in pulmonary tuberculosis.

Amongst those who have placed reliance on Arneth's method may be mentioned: (1) Kohl and Kothe[1] in appendicitis; (2) Sonnenberg and Kothe[2] in peritonitis; (3) Esser[3] in intestinal diseases of children; (4) Lewinson[4] in various diseases; and (5) Klebs,[5] Sabrazès,[6] Dluski and Rospediskowski,[7] Pottenger,[8] Minor and Ringer,[9] in pulmonary tuberculosis.

All the above-mentioned—and more could be named—agree that the work of Arneth is worthy of clinical trial.

Arneth's estimation of a normal nuclear count is as given:

| Class I. | Class II. | Class III. | Class IV. | Class V. |
|---|---|---|---|---|
| % | % | % | % | % |
| 5 | 35 | 41 | 17 | 2 |

Below are the estimates of normal counts as given by other observers:

| | Class I. | Class II. | Class III. | Class IV. | Class V. |
|---|---|---|---|---|---|
| | % | % | % | % | % |
| Cooke .. .. | 12 | 25 | 46 | 15 | 2 |
| Millar and Reed .. | 5 | 26 | 36 | 28 | 5 |
| Hamilton Black[10] .. | 8 | 28 | 42 | IV. & V.: 22% | |
| Minor and Ringer .. | 2·5 | 16·2 | 55·6 | 18·6 | 5 |

I have mentioned above the importance of careful staining at examination of the film. The personal factor is bound to creep into work like this, and for this reason alone it would be advisable for

[1] *Mitt. a. d. Grenzgeb. d. Med. u. Chir.*, xxii., p. 542, 1911.
[2] Sonnenberg and Kothe: *Deutsch. Zeitschr. f. Chir.*, p. 101, 1909.
[3] Esser: *München. med. Wochenschr.*, liii. 1651, 1906.
[4] Lewinson: *Arch. Int. Med.*, vol. ix., No. 5, p. 613.
[5] Klebs: *Am. Journ. Med. Sc.*, cxxxii., p. 538, 1906.
[6] Sabrazès: "Arch. de Mal. du Cœur, des Vaisseaux, et du Sang," p. 484, 1910.
[7] Dluski and Rospediskowski: *Beitr. z. klin. d. Tuberk.*, xiv., p. 259, 1909.
[8] Pottenger: *Journ. Am. Med. Assoc.*, lii., p. 1980, 1909.
[9] Minor and Ringer: *Am. Journ. Med. Sc.*, cxli., p. 638, 1911.
[10] Hamilton Black: "The Value of the Polymorph. Neut. Leucocyte in Disease," *Journ. Clin. Research.*, vol. vi., No. 2.

every clinician who pretends to make use of the Arneth count in medicine to get his own " normal " count by examining many films taken from persons who are known to be in good health. This procedure I have adopted myself, and find my " normal " count works out at—

| Class I. | Class II. | Class III. | Class IV. | Class V. |
|---|---|---|---|---|
| % | % | % | % | % |
| 9 | 31 | 43 | 15 | 2 |

—which is an average of twelve observations on individuals who were found healthy in all respects. Each film was examined three times, and an average struck for each person. Before passing on to the discussion of the variations which take place in the Arneth count in pulmonary tuberculosis, it may be advisable to call attention to one or two other methods which have been suggested for recording the nuclear arrangement in the polymorphonuclear leucocytes. Most of the so-called improved methods are merely modifications of Arneth's method. One of the most common procedures adopted is to take the sum of Classes I. and II. and one-half of Class III., and record the result as an " index." This plan was first adopted by Bushnell and Treuholtz,[1] and has found considerable support. It has the undoubted value, as Millar and Reed suggest, of being a convenient way of recording Arneth's count without materially altering the value of the same as a clinical entity.

Below appear the normal index value according to the various observers named:

| | |
|---|---|
| Arneth .. .. .. .. .. .. | 60·5 |
| Bushnell and Treuholtz .. .. .. .. | 67 |
| Webb and Williams[2] .. .. .. .. | 65 |
| Minor and Ringer .. .. .. .. | 48·5 |
| McDowall[3] .. .. .. .. .. .. | 57 |
| Millar and Reed .. .. .. .. .. | 54 : 46 |
| Cooke .. .. .. .. .. .. | 60 |

Wolf and Von Bonsdorff[4] count the round segments as " one," and the " bent " or " loop " forms as " one and a half "; in this way two types of nuclei are counted. The result is given as so many of " one " and so many of " one and a half." The convenience of this method is undoubted; its accuracy leaves much to be desired. Pappenheim[5] counts the total number of segments in one hundred polymorphs,

1 Bushnell and Treuholtz: *Med. Rec.*, lxxiii., p. 471, 1908.
2 Webb and Williams: Tr. Nat. Assoc. Prev. Tuberc., v. 231, 1909.
3 McDowall: " The Nuclei of the Neutrophile Cell in Acute Insanity," *Brit. Med. Journ.*, vii., p. 1462, 1912.
4 Wolf and Von Bonsdorff: *Fol. Hæmat.*, 1905.
5 Pappenheim: *Fol. Hæmat.*, 1905; also " Atlas d. menschliche Blutzellen," Jena, 1905.

and considers that sufficient. The objection to such a method is the obvious one that no information is available as to which particular class is increased. Gulland and Goodall[1] suggest that, "since the presence of a moderately high percentage of neutrophiles with rounded, kidney-shaped, or horseshoe-shaped nuclei, indicates a severe infection, the observer very soon learns to recognize that an unusual number of these cells is present without making a special differential count of the neutrophiles."

Next to Arneth's method, the most elaborate description of the nuclei of the polymorphs comes from Schilling,[2] who, using Pappenheim's method of combined May-Grünwald and Giemsa stain, classifies the polymorphs as follows:

CLASS I.—*Segmented Nucleate Polynuclears:* Cells which have two or more separate clumps of nuclear chromatin, united or not by threads; 63 per cent. in normal blood.

CLASS II.—*Rod-Nucleate Forms:* Cells which have a ribbon-like nucleus, without any clumps of nuclear chromatin; 4 per cent. in normal blood.

CLASS III.—*Juvenile Polynuclears:* Cells which have an S-shaped nucleus, with the ends of the S marked by clumps of chromatin. Arneth's T-cells are also included in this class; 0 per cent. in normal blood.

CLASS IV.—*Myelocytes:* Cells which are larger than Class III., but which have a slightly indented nucleus; 0 per cent. in normal blood.

CLASS V.—*Large Mononuclears:* 6 per cent. in normal blood.

CLASS VI.—*Lymphocytes:* 23 per cent. in normal blood.

CLASS VII.—*Basophile Cells (Mast Cells):* 1 per cent. in normal blood.

CLASS VIII.—*Eosinophile Cells:* 3 per cent. in normal blood.

Schilling's count for a normal healthy individual reads, therefore:

| Number of White Cells per c. mm. | Basophiles. | Eosinophiles. | Myelocytes. | Juveniles. | Rod Nucleates. | Segmented Nucleates. | Lymphocytes. | Large Mononuclears. |
|---|---|---|---|---|---|---|---|---|
| 6,000 | 1 | 3 | 0 | 0 | 4 | 63 | 23 | 6 |
| | | | Neutrophiles. | | | | | |

[1] Gulland and Goodall: "The Blood," p. 77. Edinburgh: Green and Son, 1914.

[2] Schilling: *Fol. Hæmat.*, vi., p. 429, 1908.

It will be noted that Schilling finds the normal number of neutrophiles to be 67 per cent. of the total count. Of this, 63 (or 94 per cent. of the total number of polymorphs) are of the segmented nucleate type, and, similarly, 6 per cent. of the total number of polymorphs are of the rod-nucleate type.

According to Schilling's own definition of segmented nucleate polymorphs (*i.e.*, cells which have two or more separate clumps of nuclear matter, united or not by threads), he must include the following cells under that term:

| | % | | % |
|---|---|---|---|
| 3K2S = | 0·4 (Arneth) | 4K = | 3·8 (Arneth) |
| 4K1S = | 0·4 ,, | 2K1S = | 16·66 ,, |
| 5K = | 1·0 ,, | 3K = | 2·27 ,, |
| 2K2S = | 4·73 ,, | 2K = | 0·27 ,, |
| 3S1K = | 1·6 ,, | 4K2S = | 0·07 ,, |
| 3K3S = | 0·07 ,, | 3K1S = | 6·4 ,, |

Total = 37·67%

In the same way, under the term rod-nucleate forms must (according to this definition) be included:

| | % | |
|---|---|---|
| 2S = | 23·46 | (Arneth) |
| 3S = | 5·6 | ,, |
| 4S = | 0·07 | ,, |
| | 29·13 | |

Again, since the juvenile polynuclears include cells with a reniform nucleus, where the indentation is " conspicuously deep," they must include Arneth's T cells, which amount to 5 per cent. of the polymorphs.

Adding together, then, the cells which may be grouped under the terms segmented nucleate forms, rod-nucleate forms, and juvenile forms, we get a total of 71·8 per cent. Reference once more to Schilling's definitions will make it clear that it is impossible to include, under his system of counting polymorphonuclear nuclei, cells like 1K1S (Arneth) or 1K2S (Arneth), which together form no less than 28·09 per cent. of the polymorphonuclear leucocytes of normal blood. It is quite possible to imagine also that cell 2K2S could, under certain modifications of its morphology, be grouped as a juvenile polynuclear (Schilling), but, according to the definition of segmented nucleate forms, it must be placed in that group (Class I., Schilling). So far as I am aware, this only too apparent error in Schilling's work has not been pointed out before, and were it not for the importance which some American writers (*e.g.*, Grüner) give it in textbooks, I should not have

laboured the question. It was not until I endeavoured to make some counts by Schilling's method that I became conscious of the difficulty of classifying cells like 1K1S and 1K2S.

Arneth's system of subdividing the polymorphs into twenty different classes is indeed much too cumbersome for general use, and I agree with those who say that for ordinary clinical work the primary division into five classes is sufficient. The essence of the opinion of Arneth and others who have worked on the subject is that there is a tendency in diseased conditions for the nuclei of the polymorphonuclear leucocytes to revert to a more or less common type, according to the severity of the infecting agent at work. The common type is represented by cells with one or two nuclear segments—cells which are believed to be approaching the myelocytic form, and which consequently indicate that there is a special call being made on the leucopoietic organs. In leukæmic conditions we are accustomed to the presence in the peripheral blood-stream of cells which are found normally in the bone-marrow only. The most important of these is undoubtedly the neutrophile myelocyte, a cell which is included by Arneth in his Class I., but which is not, of course, considered as composing a fraction of the normal blood-count. It seems awkward, however, that the myelocyte should figure in a differential count of neutrophile polymorphs when, strictly speaking, the myelocyte is not a polymorphonuclear leucocyte in any sense whatever. In all the recorded counts done by Arneth's method, I have not been able to ascertain how many cells of Class I. are really myelocytes. *A priori*, one might expect to find a fair percentage of myelocytes in a count which showed a great increase from normal in the numbers of Class I. polymorphs. Practically, the nucleus of the myelocyte does not take up the stain (amblychromatic) with the same intensity as do the ordinary polymorphs, which are in this respect trachychromatic. Although I have pointed this out, I have not in my own counts met with any cells which I could justly term myelocytes. The significance of myelocytes in certain cases strongly supports the view that the increase in the polymorphs of Classes I. and II. in patients suffering from diseased conditions is a result of marrow supply being unable to cope with the body demands, the qualitative picture suffering in consequence.

The counts done by different observers agree fairly constantly, inasmuch as they go to show that the more severe the infection, the greater is the " deviation to the left "—a phrase which means that the cells of Classes I. and II. are increased in number.

Many workers in tuberculosis have found Arneth's count of use in determining diagnosis, prognosis, and treatment. Below is a table showing some of the variations from normal occasionally met with in different conditions:

TABLE INDICATING PROPORTIONS OF NEUTROPHILE POLYMORPHS IN VARIOUS MORBID STATES.

| *Authority.* | *Disease.* | *Class I.* | *Class II.* | *Class III.* | *Class IV.* | *Class V.* | *Index.* |
|---|---|---|---|---|---|---|---|
| Arneth .. | Normal .. .. .. | 5 | 35 | 41 | 17 | 2 | 60·5 |
| Arneth .. | Acute Miliary Tuberculosis | 36 | 56 | 8 | 0 | 0 | 96 |
| Arneth .. | Active Phthisis .. .. | 14 | 56·5 | 24·5 | 4·5 | 0·5 | 82·7 |
| Arneth .. | Advanced Active Phthisis | 29·5 | 60 | 9 | 1·5 | 4 | 90 |
| Cooke .. | Erysipelas.. .. .. | 59 | 35 | 6 | 0 | 0 | 97 |
| Cooke .. | Acute Lobar Pneumonia | 57 | 26 | 15 | 2 | 0 | 90·5 |
| Cooke .. | Phthisis .. .. .. | 41 | 29 | 27 | 2 | 1 | 83·5 |
| Cooke .. | Phthisis .. .. .. | 20 | 30 | 42 | 8 | 0 | 71 |
| Hamilton Black | Chronic Phthisis .. .. | 31 | 34 | 28 | IV. & V.: 7 | | 79 |
| Hamilton Black | Acute Pneumonia .. | 28 | 40 | 27 | IV. & V.: 5 | | 81·5 |
| F. E. Taylor[1] | Phthisis .. .. .. | 18 | 64 | 17 | 1 | 0 | 90·5 |
| F. E. Taylor | Phthisis .. .. .. | 31 | 57 | 10 | 2 | 0 | 93 |
| Colin McDowall | Chronic Insanity .. .. | 5·7 | 29·5 | 45·8 | 16·8 | 1·6 | 58·1 |

[1] Taylor, F. E.: "Nuclear Segmentation of Neutrophile Leucocytes in Health and Disease," *Practitioner*, vol. xcv., No. 4, p. 503.

Taking into consideration the mass of evidence which I have endeavoured to collect from the literature, one is forced to admit of the following conclusions:

1. The "normal" Arneth count is variable within certain limits. It would appear that Class I. may form 5 to 12 per cent. of the total

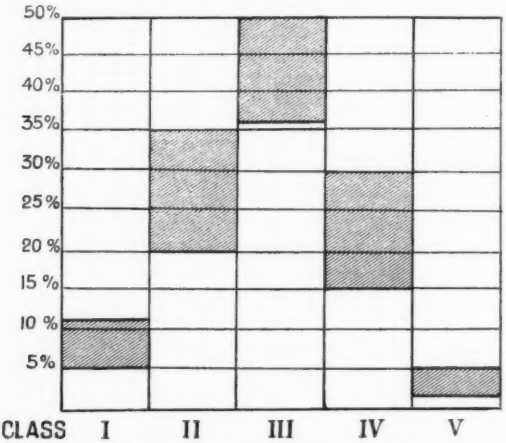



FIG. 1.—SCHEMA BUILT UP FROM THE RESULTS OF VARIOUS OBSERVERS, TO ILLUSTRATE THE RANGES WITHIN WHICH THE CELLS OF THE VARIOUS CLASSES MAY BE IN HEALTH.

number of polymorphs. Similarly, Class II. may provide 20 to 35 per cent. of the cells; Class III., 36 to 50 per cent.; Class IV., 15 to 30 per cent.; and Class V., 2 to 5 per cent. If it is suggested that the normal scope is too wide, then the only remedy I can suggest is the one I have already mentioned—viz., that each clinician should establish for himself his own normal, and construct his deductions according to that normal.

2. In certain diseased conditions there is an alteration in the nuclear picture. Reference to the counts preceding will show that in a great variety of pathological conditions one meets constantly with an increase in the percentages of cells belonging to Classes I. and II., and with a corresponding diminution in the percentages of Classes III., IV., and V. In order to arrive at some conclusion myself, I made 140 counts on 67 cases of pulmonary tuberculosis. The cases represented different phases of the disease. Below I have made a brief extract from my work on the subject, and where necessary I have given notes on physical signs in the chest, together with any other remarks which I have deemed necessary. The blood-films were made on glass slides, care being taken to obtain a thin film of blood. At least two films were taken from each patient, and the better film always examined after staining with Leishman's stain. I selected Leishman's stain as the one most useful for the work in question, because of the excellent picture it gives of the nuclei. At the beginning of my investigation I made use of Jenner's stain, Ehrlich's triacid stain, and Giemsa's stain, but soon abandoned these in favour of Leishman's, for the reason already given. At the outset of every differential count I enumerated all the leucocytes, noting the nuclear arrangement of the neutrophile polymorphs at the same time. When one hundred white cells had been counted, I confined my attention entirely to the neutrophile polymorphs until I had brought the total number of these particular cells up to one hundred. In this way I had not only a differential count of the leucocytes, but also a complete differential count of the nuclei of the polymorphs.

The majority of the observations I have to record were made on patients admitted to Stanfield Sanatorium, Burslem, where, as I have pointed out elsewhere,[1] the average type of patient was suffering from advanced disease of the chest. By the kind permission, however, of Dr. Magill, Tuberculosis Officer for the County Borough of Stoke-on-Trent, I was enabled to take films from several patients attending the tuberculosis dispensary in Stoke. It was from these patients principally that I selected my early or first-stage cases.

The cases recorded on p. 76 are a few taken from my notes. One is

[1] Magill and McDougall: "Phthisis in the Potteries," *Public Health*, August, 1916.

TABLE INDICATING VARIOUS CLASSES OF CASES OF PULMONARY TUBERCULOSIS.

| *Case.* | *Class I.* | *Class II.* | *Class III.* | *Class IV.* | *Class V.* | *Index.* | *Date.* | *Remarks.* |
|---|---|---|---|---|---|---|---|---|
| Normal | 9 | 31 | 43 | 15 | 2 | 61·5 | | |
| 1. Female | 14 | 33 | 49 | 3 | 1 | 71·5 | Aug. 20 | Æt. 20. Onset eight months previously. Left apex dull to percussion; a few crepitations heard at end of inspiration posteriorly. |
| | 12 | 30 | 47 | 9 | 2 | 65·5 | Sept. 9 | |
| 2. Female | 9 | 47 | 46 | 6 | 2 | 79 | Aug. 28 | Æt. 22. Patient in bed. Slight infiltration at right apex. General condition good. |
| | 14 | 46 | 31 | 9 | 0 | 75·5 | Sept. 11 | |
| 3. Female | 20 | 44 | 30 | 6 | 0 | 79 | May 5 | Æt. 16. General condition good. Retraction both apices. Right apex dull to percussion. A few crepitations at left apex. |
| | 13 | 39 | 36 | 11 | 1 | 70 | Sept. 26 | |
| 4. Male | 16 | 47 | 29 | 7 | 1 | 77·5 | Aug. 30 | Æt. 34. General condition good. Both upper lobes dull to percussion, and crepitations abundant. Temperature 99° F. in evenings. |
| | 14 | 40 | 39 | 6 | 1 | 73·5 | Sept. 16 | |
| 5. Female | 17 | 44 | 37 | 2 | 0 | 79·5 | Aug. 25 | Æt. 39. General condition good. Right upper lobe dull to percussion. Moist sounds heard at right apex; V.R. and V.F. exaggerated. Sputum contained tubercle bacilli. |
| | 13 | 40 | 41 | 5 | 1 | 73·5 | Sept. 9 | |
| | 12 | 38 | 39 | 8 | 3 | 69·5 | Oct. 14 | |
| 6. Female | 12 | 48 | 29 | 11 | 0 | 64·5 | Sept. 2 | Æt. 24. Entire right side of chest impaired in resonance; also left apex. Numerous moist sounds heard. Tubercle bacilli present. General condition good. |
| 7. Female | 18 | 44 | 32 | 5 | 1 | 80 | Sept. 23 | Æt. 12. Both apices lacking in normal resonance. Respiratory murmur very harsh at both apices. Numerous moist sounds over left lung. Temperature normal. |
| 8. Male | 20 | 41 | 37 | 2 | 0 | 79·5 | Sept. 30 | Æt. 20. General condition excellent. Beyond a few scattered crepitations at right apex, chest was normal, as was temperature and pulse-rate. |
| | 18 | 38 | 31 | 11 | 2 | 71·5 | Oct. 8 | |
| 9. Male | 12 | 50 | 25 | 10 | 3 | 74·5 | Aug. 28 | Æt. 35. Right apex impaired in resonance; a few moist sounds heard. Temperature normal. |

compelled to admit that there is a deviation from normal in the nuclear arrangement. In most of the cases of this group the lesion in the chest is slight; in some, the diagnosis was doubtful altogether, and it would be presumptuous to suppose, as some have done, that one is enabled to diagnose pulmonary tuberculosis from an index which differs so little from normal. In some of the cases the increasing resisting powers of the individual were shown to be improving by successive readings made at monthly intervals. The conclusion one must come to in regard to cases of early tuberculosis of the lungs is that, while there is undoubtedly a "deviation to the left" of the nuclear picture, this is of no definite value in diagnosis. It occurs in many other conditions.

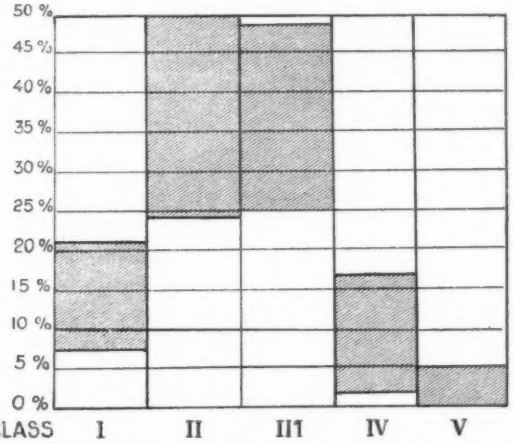



FIG. 2.—SCHEMA ILLUSTRATING THE RANGES WITHIN WHICH THE CELLS OF THE VARIOUS CLASSES MAY BE IN EARLY CASES OF PULMONARY TUBERCULOSIS—*i.e.*, WHEN THE POWERS OF RESISTANCE ARE ONLY SLIGHTLY IMPAIRED.

This opinion is shared by many other writers on the subject. It is to be noted, however, that in some cases, although the physical signs in the chest pointed to extensive disease, yet the blood-picture is remarkably little altered. Following the theory advanced by Arneth that the powers of resistance are to be gauged by the proximity of the nuclear count to normal, one may deduct positively from these cases that the prognosis is good, more particularly if the count remains approximately normal at successive examinations.

Cases 10 to 15 are illustrative of patients suffering from tuberculous disease in whom the nuclear index is approximately between 80 and 90 (see p. 78).

Comparison of the cases in this second group with the cases in the

TABLE INDICATING VARIOUS CLASSES OF CASES OF PULMONARY TUBERCULOSIS.

| *Case.* | *Class I.* | *Class II.* | *Class III.* | *Class IV.* | *Class V.* | *Index.* | *Date.* | *Remarks.* |
|---|---|---|---|---|---|---|---|---|
| 10. Female | 36 | 31 | 32 | 1 | 0 | 83 | Sept. 16 | Æt. 27. Pleurisy seven years previously. Had hæmoptysis at frequent intervals. Both apices lacking in resonance, especially left. Respiratory murmur harsh over both upper lobes; a few crepitations heard on deep inspiration. |
| | 31 | 31 | 37 | 1 | 0 | 80·5 | Oct. 4 | |
| 11. Male .. | 28 | 34 | 36 | 2 | 0 | 80 | Dec. 12 | Æt. 21. General condition good. Right upper lobe dull to percussion; respiratory murmur very harsh. No adventitious sounds. No temperature. |
| 12. Female | 27 | 30 | 36 | 1 | 0 | 81 | Sept. 23 | Æt. 12. Right base impaired in resonance, with diminution in respiratory murmur. A few moist sounds heard in left axilla. |
| 13. Female | 39 | 45 | 15 | 1 | 0 | 91·5 | Sept. 14 | Æt. 23. General condition good. Both cords at arytenoids congested. Right apex dull to percussion. A few crepitations heard. |
| | 36 | 41 | 22 | 1 | 0 | 88 | Oct. 7 | |
| 14. Male .. | 27 | 49 | 23 | 1 | 0 | 87·5 | Sept. 16 | Æt. 28. Rhonchi and crepitations heard all over chest. Duration of disease was four years. General condition good. |
| 15. Female | 32 | 41 | 26 | 1 | 0 | 86 | Aug. 18 | Æt. 31. Right apex impaired in resonance. A few scattered crepitations at right apex. Temperature normal. General condition good. |
| | 30 | 40 | 28 | 2 | 0 | 84 | Aug. 31 | |
| | 29 | 43 | 27 | 1 | 0 | 85·5 | Sept. 23 | |
| | 29 | 41 | 29 | 1 | 0 | 84·5 | Oct. 11 | |

first group shows that the disease is, in most cases, more extensive in the former than in the latter. That this is not always so, however, is exemplified by cases such as No. 15, where the lesion in the chest was comparatively slight. The deduction to be made from the Arneth count in these cases is that it is an indication of the intensity of the process rather than of the extent of the lesion. A further point of importance is that in none of the cases in the second group, where several counts were made, was there any very definite improvement

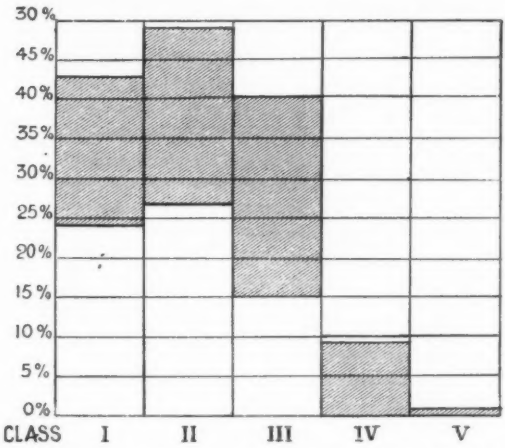



FIG. 3.—SCHEMA ILLUSTRATING THE RANGES WITHIN WHICH THE CELLS OF THE VARIOUS CLASSES MAY BE IN MODERATELY INTENSE TUBERCULOSIS—*i.e.*, WHEN THE POWERS OF RESISTANCE ARE MORE MARKEDLY IMPAIRED THAN IN THE CASE OF GROUP I.

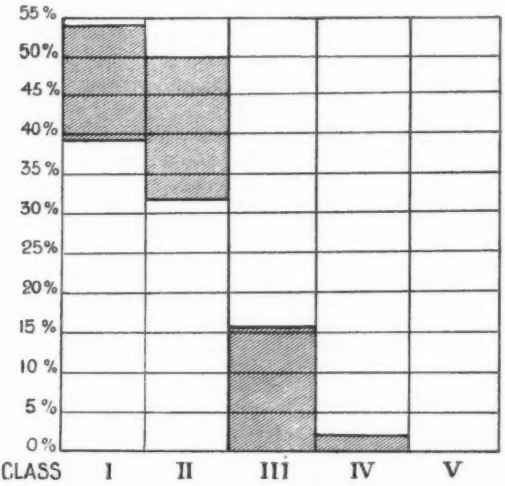



FIG. 4.—SCHEMA ILLUSTRATING THE RANGES WITHIN WHICH THE CELLS OF THE VARIOUS CLASSES MAY BE IN SEVERE TUBERCULOUS INFECTION—*i.e.*, WHEN THE POWERS OF RESISTANCE ARE MARKEDLY IMPAIRED.

in the nuclear index, despite the fact that in some there was a substantial drop in the leucocytes of Class I. The paucity of polymorphs of Class IV. is yet another feature which merits attention, and points to the extreme sensibility of these cells in a tuberculous infection.

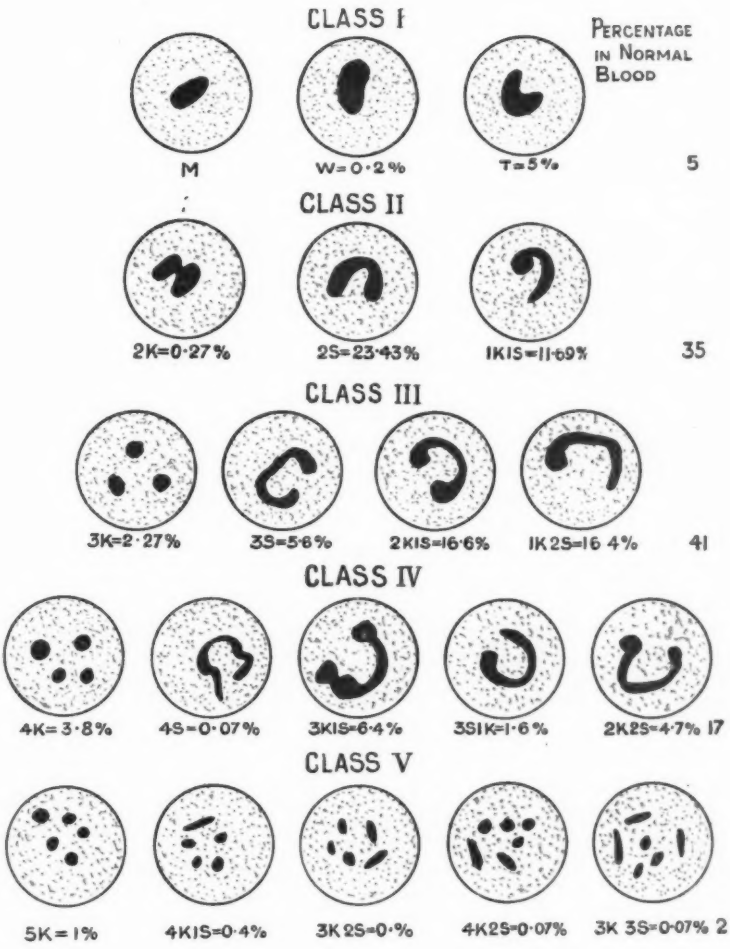
In Group 3 the cases are, almost without exception, cases of advanced or apparently advancing disease. Despite the remarkable variations in the symptoms and signs shown by the patients, the large amount of "deviation to the left" in the nuclear count is a feature common to all.

One case especially (No. 20) is deserving of attention. It would indeed be difficult to find another sign in medicine which would have convinced one that the disease was acute and progressive. A parallel case is recorded by Minor and Ringer.[1] If the Arneth count served no other purpose than to distinguish acute from apparently chronic or early cases, its service in clinical medicine would be enormous.

TABLE INDICATING VARIOUS CLASSES OF CASES OF PULMONARY TUBERCULOSIS.

| *Case.* | *Class I.* | *Class II.* | *Class III.* | *Class IV.* | *Class V.* | *Index.* | *Date.* | *Remarks.* |
|---|---|---|---|---|---|---|---|---|
| 16. Male | 41 | 29 | 27 | 3 | 0 | 83·5 | Aug. 26 | Æt. 20. Onset two and a half years previously. Right hip-joint diseased. Several discharging sinuses over hip-joint and sacrum. Chest examination revealed poor air entry at both apices, with a few crackling râles at right apex. Temperature was normal. |
| | 44 | 40 | 15 | 1 | 0 | 91·5 | Sept. 23 | |
| | 46 | 39 | 15 | 0 | 0 | 92·5 | Oct. 9 | |
| | 46 | 40 | 13 | 1 | 0 | 92·5 | Nov. 14 | |
| 17. Male | 42 | 46 | 12 | 0 | 0 | 94 | Aug. 28 | Æt. 24. Onset three months previously. Family history bad. General condition poor. Temperature 99° to 102° F. Pulse 100 to 110 per minute. Left upper lobe dull to percussion, also right upper lobe. Numerous moist sounds to be heard all over left lung at right upper lobe. Sputum contained tubercle bacilli, streptococci, staphylococci, and numerous diplococci. Patient died December 24. |
| | 47 | 45 | 8 | 0 | 0 | 96 | Sept. 19 | |
| | 48 | 45 | 7 | 0 | 0 | 96·5 | Oct. 8 | |

[1] *Loc. cit.*




GRAPHIC REPRESENTATION OF ARNETH'S SYSTEM (AFTER GRÜNER).

M=Myelocyte. W=Wenig (Slight). T=Tief (Deep). S=Schlinge (Loops).
K=Runder Kerutiel (Round Nuclei).

TABLE INDICATING VARIOUS CLASSES OF CASES OF PULMONARY TUBERCULOSIS—*Continued.*

| Case. | Class I. | Class II. | Class III. | Class IV. | Class V. | Index. | Date. | Remarks. |
|---|---|---|---|---|---|---|---|---|
| 18. Female | 41 | 46 | 13 | 0 | 0 | 93·5 | Oct. 8 | Æt. 17. General condition poor. Large cavity in left upper lobe. Crepitations heard all over both lungs. Temperature 98° to 101·6° F. Died five months later. |
| | 40 | 48 | 12 | 0 | 0 | 94 | Oct. 17 | |
| 19. Male .. | 52 | 48 | 0 | 0 | 0 | 100 | Oct. 8 | Æt. 16. General condition poor. Both lungs dull to percussion. Crepitations heard all over chest. Temperature 100° to 102·6° F. Pulse 120. Died one month later. |
| 20. Male .. | 47 | 42 | 11 | 0 | 0 | 94·5 | May 22 | Æt. 27. Bad family history. General condition good. Right apex lacking in resonance; a few crepitations heard at the end of inspiration. Temperature normal at time of examination. Died three months later, after profuse hæmoptysis following an attack of "influenza." |
| 21. Female | 42 | 46 | 12 | 0 | 0 | 94 | Aug. 19 | Æt. 28. Both upper lobes dull to percussion. Cavity formation at right upper lobe. Crepitations over right lung, and at apex of left. Temperature 98° to 101° F. Pulse 100. Died three months later. |
| | 46 | 47 | 7 | 0 | 0 | 96·5 | Aug. 28 | |
| | 45 | 46 | 9 | 0 | 0 | 95·5 | Sept. 7 | |
| | 47 | 49 | 4 | 0 | 0 | 98 | Sept. 11 | |

Further detailing of cases belonging to Group 3 seems unnecessary. The figures obtained from all my cases show that there is a very definite nuclear change in the polymorphonuclear nuclei. In every case where the index is over 90 (*e.g.*, No. 20) it behoves one to regard the case as dangerous, and for ordinary purposes one must regard an index of over 90 as an alarm signal, even when the patient's general condition is apparently good. The presence of a high nuclear index may be taken, then, as an indication of feeble resistance on the part of the patient; and as a high index is synonymous with an excess of cells of Classes I. and II., these cells must be looked upon as the last representatives of the defensive mechanism, and consequently of serious import.

Most of the patients in Group 3 were "third-stage" cases—the majority had a swinging temperature, tubercle bacilli and other organisms in the sputum, increased pulse-rate, and most of the other symptoms characteristic of extensive, or acute and progressive, disease.

The effect of secondary organisms on the number of leucocytes in the circulating blood I have shown elsewhere.[1] Suffice to say here that the long-continued call on the leucocytes such as is demanded by so-called third-stage cases must inevitably lead to a marrow exhaustion, in quality if not in quantity.

As I have said above, the precise significance of the "deviation to the left" in the presence of an intoxication is problematical; the explanation depends very much upon the view one takes of the function of the polymorphonuclear leucocyte. There is much evidence to show that the relation of this cell to the immunizing processes going on in the body is much more intimate than was at one time admitted. Metchnikoff has maintained that the neutrophile granules of the polymorph are the secretors of complement. Schneider's work[2] corroborates this theory. Certain it is that, if we regard the adult neutrophile leucocyte in health to be the normal, then the abnormal in disease differs from it, not only in nuclear structure, but also in cytoplasmic consistence. Accurate study of the neutrophile granules is not very easy, for obvious reasons, but one might suggest that cells lacking in nuclear matter—*e.g.*, Class I. and II. cells—are not in a position to nourish the cytoplasm as efficiently as the cells of Classes III. and IV. Be that as it may, the fact remains that with an ebbing immunity and an approaching death, the cells of Classes I. and II. predominate over the others, and, conversely, with an increasing immunity and improving health there is a tendency for the nuclear picture to attain once more its normal proportions.

[1] McDougall, J. B.: "A Study on the Leucocyte Count in Pulmonary Tuberculosis," ***Brit. Jour. Tub.***, vol. x., No. 4.

[2] Schneider: "Med.," p. 499, 1908; see also Grüner: "Biology of the Blood-Cells," p. 224. Bristol: Wright, 1913.

# INSTITUTIONS FOR THE TUBERCULOUS.

## THE CAMBRIDGESHIRE TUBERCULOSIS COLONY.

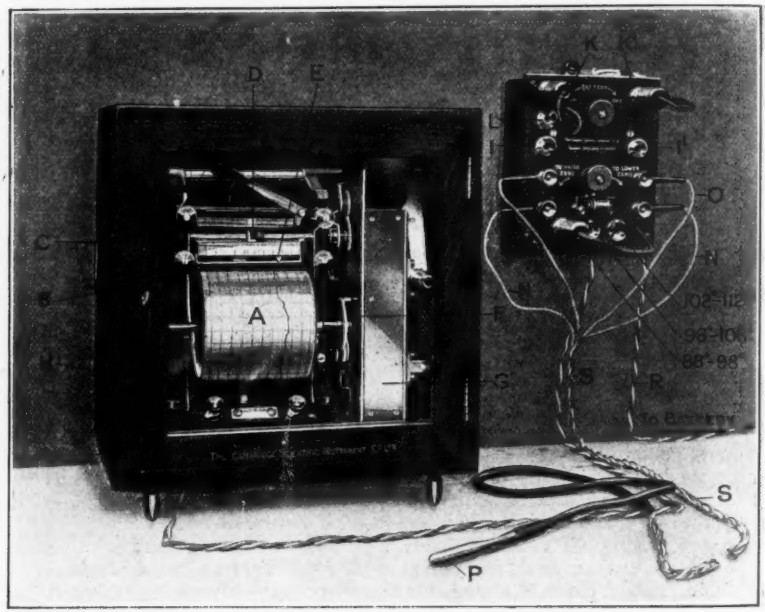
THROUGH the courtésy of Dr. P. C. Varrier-Jones, Acting Tuberculosis Officer and Medical Adviser to the Insurance Committee for the County of Cambridgeshire, we have been favoured with the following account of an experiment which is rich in promise:

"The Tuberculosis Colony, Bourn, Cambridgeshire, was founded by the writer two years ago. It was started to meet the need of sanatorium accommodation, which should be cheap, yet at the same time efficacious. No expensive buildings were erected, the administrative block being a small country house. This served as the nucleus around which portable shelters were erected for the accommodation of the patients. An open-air dining-hall and recreation-room placed in the grounds completed the scheme. Only early cases are admitted, and the patients are engaged in remunerative occupation, such as shelter-making, path-building, gardening, and poultry-keeping, together with other light occupations, such as fixing telephones, electric bells, and doing general repairs. In other words, the patients are true colonists, engaged in building up their own colony. Each patient is engaged as far as possible at his particular trade, and it is found that, under these conditions, a keen rivalry is maintained with regard to the quality of the work done. This is also shown by the fact that ex-patients visit the colony from time to time, and are keenly interested in the progress which is being made. The medical staff consists of the Acting Tuberculosis Officer for the county, assisted by the local panel doctor. The nursing staff is composed of a sister-in-charge and one nurse. A unique feature of the scheme is the installation of a continuous temperature apparatus, by means of which a patient's temperature is taken for twenty-four hours and recorded automatically. The cable is attached to the thermometer in one of the shelters—the observation shelter—and is conducted to a room in the administrative block, where the record is visible. The accompanying illustration shows the complete outfit, comprising a Darwin thread recorder and a Varrier-Jones rectal continuous thermometer. Records are taken from time to time, on admission, and before discharge. The value of this form of temperature recording has already been demonstrated when used in connection with the tuberculin test in cattle,[1] and the results at the colony show[2] that

[1] Varrier-Jones and Woodhead: "Quasi-Continuous Temperature Records in Healthy and Tuberculous Bovine Animals," *Journal of Comparative Pathology and Therapeutics*, Edinburgh and London, 1915, vol. xxviii., p. 337.

[2] Woodhead and Varrier-Jones: "Clinical Thermometry: Continuous and Quasi-Continuous Temperature Records in Man and Animals in Health and Disease," *Lancet*, London, 1916, vol. i., January 22, p. 173; February 5, p. 281; February 12, p. 338; February 26, p. 450; and March 4, p. 405.

it is a valuable indication of the patient's progress as well as an accurate means of diagnosis. It has been found possible to start such an institution on the small capital of £500, and it is maintained exclusively out of the charges paid on behalf of the patients received. The colony is recognized by the Local Government Board and the Insurance Commissioners. The charge at the present time is 30s. per week."




APPARATUS FOR THE CONTINUOUS RECORD OF TEMPERATURE.

A, Drum on which temperature is charted; B, inked thread; B′, spring keeping inked thread taut; C, presser-bar on which scale is marked; C′, spring raising presser-bar; D, cam rod with two cams (rod revolves once in two minutes, presser-bar lowered once per minute); E, knife-edge at end of galvanometer lever; F, gear wheels to alter rate of revolution of drum; G, driving clock; G′, slave clock; $G^2$, fly-wheel; $G^3$, fly-wheel stop; H, resistance coil now combined with thermometer leads, so that any thermometer may be used; I and I, zero plugs; K and K′, recording plugs; L, calibrating plug; M, slide wire for calibrating; N, dummy leads; O, thermometer leads; P, thermometer; R, battery leads; S, combined leads; T, suspended coil; U, suspended wire or torsion head; V, clamping screw; W, wire engaging with cam; X, magnet; Y, connecting lead; Z, frame.

# NOTICES OF BOOKS.

## DOMICILIARY CARE OF CONSUMPTIVES.

War is rendering difficult the maintenance and extension of institutional treatment for tuberculosis, and it would seem probable that for some time to come large numbers of tuberculous cases will have to be cared for in their own homes. It is essential that all responsible in any way for the domiciliary management of consumptives should fully understand all principles and practices for the hygienic care and control of these cases. A valuable and thoroughly practical manual on the subject has been prepared by Mr. Roy L. French.[1] It admirably indicates essentials for the loyal co-operation of the patient, the patient's family, and the nurse and doctor. It is, indeed, a live mine of practical information, and will be of real service to medical practitioners, nurses, health visitors, and social workers, as well as to those who are the subjects of tuberculosis. An excellent chapter on "Hints and Helps for Tuberculosis Patients" is contributed by Dr. Charles L. Minor; and Miss Laura A. Cauble writes on "Foods and their Preparation." There is a useful appendix given of information regarding manufacturers of preparations and appliances, together with a serviceable bibliography. The instructive illustrations add much to the helpfulness of the book.

## CLINICAL THERMOMETRY.

In the management of tuberculosis the thermometer is an indispensable instrument. Many studies regarding the temperature in tuberculous subjects have been conducted, and numerous articles have been published. The record of a particularly valuable investigation on clinical thermometry has been issued in brochure form by Professor G. Sims Woodhead and Dr. P. C. Varrier-Jones, and we commend a study of this interesting and suggestive monograph to all tuberculosis officers and others engaged in the supervision and treatment of tuberculous cases.[2]

[1] "Home Care of Consumptives." By Roy L. French, former Secretary, Kentucky Tuberculosis Commission. Pp. xii + 219, with 27 illustrations. New York and London: G. P. Putnam's Sons. 1916. Price $1.00 net.

[2] "Investigations on Clinical Thermometry: Continuous and Quasi-Continuous Temperature Records in Man and Animals in Health and Disease." By G. Sims Woodhead, M.A., M.D., LL.D., Professor of Pathology, Cambridge; and P. C. Varrier-Jones, M.A., M.R.C.S., L.R.C.P., Foundation Scholar, St John's College, Cambridge, and Acting Tuberculosis Officer for the County of Cambridge. Reprinted from the *Lancet*, January 22; February 5, 12, 26; and March 4, 1916. See also article by the same authors on "Quasi-Continuous Temperature Records in Healthy and Tuberculous Bovine Animals, especially in Relation to the Tuberculin Test." Reprinted from the *Journal of Comparative Pathology and Therapeutics*.

## THE NEW PHYSIOLOGY.

Physiology provides the foundation on which a true study and serviceable understanding of man and of all scientifically directed measures to maintain him in health and to rescue him from disease must be firmly based. This branch of biological science has made rapid strides during recent years, and both "abstract" and "applied" physiology now require effective representation. A notable volume has recently appeared, written by Professor W. M. Bayliss.[1] It is an erudite work, written with much literary charm, setting forth the fundamental facts and basal principles of physiology in a new and directing light, and with philosophic insight and lucid exposition setting forth the best modern views on the problems of vital processes. The book is a handsome one, lavishly illustrated, and a praiseworthy and attractive feature is provided by numerous portraits of distinguished physiologists. Some idea of the purpose and scope of this illuminating treatise may be indicated by an enumeration of the titles of some of the leading chapters: Protoplasm, Energetics, Surface Action, The Colloidal State, Osmotic Pressure, Electrolytes, Nutrition, Catalysis and Enzymes, Excitation and Inhibition, Receptor Organs, Oxidation and Reduction, Hormones, Drugs, and Toxins. There is a remarkably representative bibliography, and the index is in every way admirable. Brief though this notice must be of necessity, it will, we trust, be sufficient to indicate that this is a work which should be studied in its entirety by every physician and all serious students of general physiology. Professor Bayliss has accomplished a difficult task with conspicuous success.

## MANUALS FOR MEDICAL ADVISERS AND WORKS OF REFERENCE.

The second edition of the "Encyclopædia Medica," under the able editorship of Dr. J. W. Ballantyne, is making steady progress, in spite of the manifold perplexities of these troublous times. Vol. IV. has recently been issued, and treats of subjects from "Ear to Filariasis"; and, like its predecessors, is characterized by thoroughness.[2] It is a work of reference which no medical practitioner can afford to be without. There are no less than thirty-seven "principal articles" in the present volume, and the contributors include many of our best-known medical teachers and writers. Among the sections likely to be of special interest and service to our readers, the following may be referred to: Authoritative articles on the Examination and Diseases of the Ear, by Dr. J. K. Milne Dickie, Mr. P. Macleod Yearsley, Mr. W. Jobson Horne, Dr. Thomas Barr, Sir William Milligan, Dr. M'Kenzie Johnston, Mr. A. H. Cheatle, Mr. J. S. Fraser, and Dr. Dundas Grant; Eczema, by Dr. H. Leslie Roberts; Enzymes, by Dr. R. Tanner Hewlett; Epidemiology, by Dr. Andrew Davidson; Eugenics,

[1] "Principles of General Physiology." By William Maddock Bayliss, M.A., D.Sc., F.R.S., Professor of General Physiology in University College, London. Pp. xx+850. With 259 illustrations. London: Longmans, Green and Co., 39, Paternoster Row, E.C. 1915. Price 21s. net.

[2] "Encyclopædia Medica." Second Edition. Under the General Editorship of J. W. Ballantyne, M.D., C.M., F.R.C.P.E. Vol. IV.: Ear to Filariasis. Pp. viii+685, with plates and illustrations. Edinburgh: W. Green and Son, Ltd., 2 and 4, St. Giles Street. 1916. Price 20s. net.

by Dr. C. W. Saleeby; and Expectoration, by Dr. J. Stewart Fowler. It should be noted that the Editor contributes an able up-to-date exposition on Human Embryology. The volume is well got up, excellently printed on good paper, strongly bound, and altogether is an attractive and effective production, concerning which all who have participated in its production may well be proud.

Medical superintendents of sanatoria and tuberculosis officers and other physicians engaged in the care of tuberculous subjects have often to advise in regard to affections of the ears. A particularly serviceable work on otology has recently been written by Dr. C. E. Perkins, and deserves to be known by all practitioners of medicine.[1] It is a manual of instruction for students and practitioners by an expert who has had long experience of the subject the principles and practice of which he provides so able an exposition. The manual is an authoritative one, provides detailed instructions for the examination of the ear, the detection of various pathological conditions, and the conduct of operative and other methods of treatment. There is an excellent section on "Tuberculosis of the Ear," and the following opinion may be quoted: "The prognosis in tuberculosis of the middle ear is as a rule unfavourable. When it occurs in advanced pulmonary tuberculosis it may not materially contribute to the fatal outcome. In some instances, however, it leads to a fatal issue by producing labyrinthitis and meningitis. The possibility of the process being primary and acting as a focus of infection should also be borne in mind. If the patient's general health improves, the local ear process sometimes gets well. After the mastoid operation the wound may heal, but it frequently fails to do so." As regards treatment, the following advice is given: "In primary tuberculosis of the mastoid and middle ear, free opening of the bone and removal, so far as possible, of all diseased tissue is indicated. In children with complicated enlarged lymph nodes, a like procedure should be undertaken. In the chronic type occurring in pulmonary tuberculosis the condition of the lungs largely determines whether or not operation is advisable. The process in the temporal bone may be of such a nature as to menace life, and must then be dealt with surgically. The bone destruction may progress without producing marked symptons, and the insidious nature of the process must be borne in mind. If the pulmonary condition is quiescent, the general nutrition good, and the local aural disease seems to be hindering convalescence, an operation is justifiable. If, on the other hand, the disease in the lungs is getting worse, and the disease in the temporal bone seems merely an incident, operation will only hasten the end. An item is the effect of the anæsthetic on the lungs. If it becomes necessary to perform an operation on a patient with pulmonary involvement, ether should not be administered. The safest anæsthesia is by the 'gas-oxygen' method, which seems to have less unfavourable effect on the lungs. The general health of these patients with tubercular ear processes demands special attention. Their resistance and nutrition should be increased by all means possible."

[1] "A Manual of Otology for Students and Practitioners." By Charles Edwin Perkins, M.D., F.A.C.S., Professor of Clinical Otology in New York University and Bellevue Hospital Medical College. Pp. 445, with 120 illustrations. Philadelphia and New York: Lea and Febiger, 706-710, Sansom Street, Philadelphia. 1916. Price $3.00.

Dr. G. C. Shattuck has issued a new edition of his excellent little manual on treatment.[1] It is a remarkably concise and condensed presentation of sound principles based on established pathology. Opposite each page of type is a blank page for the practitioner's notes. Dr. J. B. Hawes, 2nd, contributes the section on Pulmonary Tuberculosis, and with regard to tuberculin states dogmatically that "the general practitioner should not undertake this form of treatment." It is also stated that "drugs, in the treatment of pulmonary tuberculosis, are used merely to treat symptoms—never the disease itself."

The Housing Problem is closely associated with the Tuberculosis Problem, and no students of the latter can afford to be neglectful of essentials in regard to the former. Dr. A. Maxwell Williamson, Medical Officer of Health for Edinburgh, has published a valuable brochure on housing which merits careful consideration.[2]

Mr. Edgar L. Chappell, the Secretary of the Welsh Housing and Development Association, has edited a volume which contains a number of valuable contributions on various aspects of the Housing Problem in the Principality of Wales.[3]

Commandants of War Hospitals and others interested in the instruction and supervision of hospital orderlies will find much that is of practical service in Dr. N. Corbet Fletcher's new brochure.[4]

Mr. C. T. Kingzett has just issued a compact, well-arranged, up-to-date elementary primer of chemistry which should prove popular in schools and among general readers desirous of a short, reliable, and general presentation of the fundamental principles and facts of modern chemistry.[5]

Many doctors and heads of sanatoria have for long been accustomed to make use of motor-cars. During the past two years difficulties have steadily increased, and in most instances medical practitioners are compelled to drive their own cars. To all such an excellent little volume of hints and suggestions and practical directions on "How to Drive a Motor-Car" may be commended.[6] Even expert drivers will find much in its pages which will be of service, and the inexperienced will welcome the wise admonitions and sensible warnings which are effectively presented in pictures and diagrams, as well as in concise and clear words.

[1] "Principles of Medical Treatment." By George Cheever Shattuck, M.D., Assistant Physician to the Massachusetts General Hospital. Third Edition, revised and enlarged. Pp. 225. Boston, U.S.A.: W. M. Leonard. 1916. Price $1.50.

[2] "The Influence of Housing on Health." By A. Maxwell Williamson, M.D., B.Sc., Medical Officer of Health, Edinburgh. Pp. 22. Printed for the Scottish Labour Housing Association at Glasgow.

[3] "The Welsh Housing and Development Year-Book, 1917." Edited by Edgar L. Chappell. Pp. 102. Cardiff: The Welsh Housing and Development Association, 18, Queen Street. 1917. Price 1s. net.

[4] "Hints for Hospital Orderlies (Orderly Duties Simplified and Tabulated). By N. Corbet Fletcher, M.B., B.A., B.C., M.R.C.S., L.R.C.P. Pp. 58. London: John Bale, Sons and Danielsson, Ltd., 83-91, Great Titchfield Street, Oxford Street W. 1917. Price 6d. net.

[5] "Chemistry for Beginners and for Use in Primary and Public Schools." By C. T. Kingzett, F.I.C., F.C.S., Past Vice-President Society of Public Analysts. Pp. 106. London: Baillière, Tindall and Cox. 1917. Price 2s. 6d. net.

[6] "How to Drive a Motor-Car: A Key to the Subtleties of Motoring." Written and illustrated by the staff of *The Motor*. Fourth Edition. Pp. 138, with illustrations. London: Temple Press, Ltd., 7-15, Rosebery Avenue, E.C. 1917. Price 1s. 6d. net.

# PREPARATIONS AND APPLIANCES.

## A BANDAGE WINDER.

THE Medical Supply Association have introduced a novel little BANDAGE WINDER, compact and convenient for the pocket, effective in use and inexpensive.[1] Its form and chief points are illustrated in the accompanying figure. It will permit the winding of bandages up to 3 inches wide.

## FIRE-LIGHTERS.

The responsible heads of hospitals and sanatoria, as well as ordinary householders, are now eager to secure time and labour saving contrivances. Their attention should be directed to the "CERTO" PATENT FIRELIGHTER.[2] It dispenses with paper and wood, saves money, lightens labour, economizes time, makes for cleanliness, can be conveniently stored without undergoing deterioration, and can be handled without danger. The "Certo" lighter, when properly opened, placed in the fireplace upon a bed of cinders and covered with cinders and coal, affords a simple and expeditious means of procuring a good fire with the minimum of trouble. We have tried the "Certo" and can commend them. They only need to be known to be appreciated and widely used.

## REQUISITES FOR THE SANATORIUM AND ITS PATIENTS.

INHALONE is an excellent antiseptic soothing and emollient preparation for application to the nasal passages in various catarrhal affections.[3] It contains phenol, eucalyptol and menthol in a bland aromatized oleaginous base. It is contained in a collapsible tube which admirably provides for portability, protection, and convenience in application.

[1] The Pocket Bandage Winder is supplied by the Medical Supply Association, 167-185, Gray's Inn Road, London, W.C. Price 1s., post-free 1s. 3d.

[2] The "Certo" Patent Firelighters, as supplied to H.M. Government are manufactured by Certo Limited, 42, High Street, Hampton Wick, Middlesex. Price to hospitals per 1,000, 35s., carriage paid.

[3] "Inhalone" is prepared by Messrs. Parke, Davis and Co., 40, Beak Street, Regent Street, London, W., in tubes, 1s. each.

Various iodine preparations have been used in the treatment of tuberculous affections. A new form of iodine in organic combination is now available in the new preparation of CALCIUM IODO-RECINOLEATE, which certainly seems to merit thorough testing in chest cases.[1]

A simple, effective, and inexpensive form of VAPOFORM DISINFECTANT has been introduced which should be of service in dealing with rooms in the home or wards in the hospital used by consumptive and other infectious cases.[2] The apparatus is complete, self-contained, and is supplied in convenient boxes. Two sizes are provided; the smaller is estimated to disinfect a room of from 1,000 to 2,000 cubic feet, while the larger is said to be capable of dealing with one from 3,000 to 6,000 cubic feet.

Under the designation of YADIL an antiseptic has recently been introduced which promises to be of service in dealing with tuberculous cases. Chemically a trimethenal allylic carbide compound, it is non-caustic and non-toxic, and can be used internally as well as externally.[3] Having strong bactericidal powers, and being excreted largely by the skin and lungs, it certainly merits a thorough trial. It is a clear liquid miscible with water, and can be taken internally with milk, tea, or other beverages. It does not coagulate albumin, and is innocuous to living tissues, although possessing powerful germicidal properties.

"BACTEROL" is another disinfectant which will be found of service in sanatorium work and in dealing with consumptives and other tuberculous subjects.[4] It is available in five types; those of most interest and value in medical practice are the "Medical," "General," and "Aeriform" varieties. They are non-poisonous, non-corrosive, non-greasy, non-staining, and possess deodorant and germicidal properties.

Under the general designation of "KEROL" a series of valuable disinfectant, sanitary, and cleansing preparations have been introduced.[5] These will be of much value in hospital and sanatorium work, as well as for use in private houses, schools, camps, and other centres.

BOVININE is a nutrient and stimulant which is valuable in the treatment of tuberculous cases and other diseases associated with malnutrition.[6] It is no new preparation, but has stood the test of long trial, and has won a foremost place in hospital and general practice.

[1] Calcii Iodo-recinoleatis (capsula) in the "Tabloid" brand is supplied by Burroughs, Wellcome and Co.

[2] The Vapoform Disinfectant is supplied by Harkness, Beaumont and Co., Manufacturing Chemists, Junction Bridge, Edinburgh, at 7½d. and 1s., and full particulars will be sent on application.

[3] The name "Yadil" has been registered for the new antiseptic by the makers, Messrs. Clement and Johnson, 19, Sicilian Avenue, London, W.C., from whom full details can be obtained by tuberculosis officers and other medical practitioners.

[4] Full particulars regarding the "Bacterol" preparations may be obtained on application to Messrs. Menley and James, Ltd., Menley House, Farringdon Road, London, E.C.

[5] Full particulars regarding the Kerol Standardized Preparations may be obtained on application to the makers, Quibell Brothers, Ltd., Manufacturing Chemists, Newark.

[6] Full particulars regarding Bovinine can be obtained from the Bovinine Company, 75, West Houston Street, New York City, or the British agents, William Edwards and Son, 157, Queen Victoria Street, London, E.C.

# THE OUTLOOK.

## TUBERCULOSIS AND THE LOCAL GOVERNMENT BOARD.

SIR ARTHUR NEWSHOLME in his latest report as Chief Medical Officer to the Local Government Board, the State Department dealing with Tuberculosis, has some interesting facts and records dealing with the present position in regard to tuberculosis.[1] We quote the following:

"Owing to the necessity to free as many medical officers engaged in the treatment of tuberculosis as possible for military service, it has been necessary to reduce the amount of work in many areas by temporarily abandoning certain classes of work, such as the systematic examination of the home contacts of tuberculous persons. This is regrettable, as the reduction of tuberculosis can best be secured by this and other preventive and social work, which should go hand in hand with the actual treatment of patients. In some areas the entire staff of tuberculosis officers has been freed for military service; their places often being taken by women medical officers or in part by general practitioners. In some areas the local circumstances have made it necessary to retain a portion of the original staff in order to maintain a minimal service. The number of beds available in residential institutions has increased during the year, the number of beds on April 3, 1915, being 10,045, and on April 1, 1916, 11,157. This number of beds would probably not have been adequate had it not been for the fact that under war conditions, with high wages, tuberculous persons have often not been willing to receive treatment in sanatoria. In the majority of counties and county boroughs there is still a shortage of hospital beds for patients suffering from advanced disease. In a number of residential institutions and dispensaries the arrangements are still not satisfactory, but they have received continued temporary approval until after the war. Special accommodation for the treatment of children in residential institutions was insufficient at the outbreak of war, and as there was no prospect of any considerable increase of accommodation during the war, arrangements, which would not have been approved in normal times, have been sanctioned, with the concurrence of the Board of Education, for the treatment of children in institutions primarily intended for adults. Owing to the strain imposed on tuberculosis officers and others, no returns of the work carried out by the dispensaries and residential institutions have been required by the Board, and no statistical statement is, therefore, given of the work during 1915. Returns for the year 1915 will, however, be asked for at a later date. Arrangements were made in the early part

[1] Forty-fifth Annual Report of the Local Government Board, 1915–16. Supplement containing the Report of the Medical Officer for 1915–16, pp. xxxii+77. London: H.M. Stationery Office, Imperial House, Kingsway, W.C. [Cd. 8423.] 1917. Price 9d. net.

of 1915 under which the Board undertook to secure free treatment in residential institutions of all uninsured men discharged from the navy and army on account of tuberculosis who needed and were willing to receive such treatment; similar arrangements being made by the Insurance Commission for insured men. Although suitable accommodation was provided in every case, usually through the local tuberculosis scheme, a considerable number of men declined to avail themselves of the free treatment; and some who accepted treatment took their discharge within a few days after transfer from the military hospital. This is regrettable, as in the interests of the patient himself and of the public it is most important that all tuberculous sailors and soldiers should receive a period of treatment and education in a residential institution. It may be noted that when a soldier suffering from tuberculosis is discharged from the army the Medical Officer of the military hospital notifies the Medical Officer of Health of the district to which the soldier is to proceed, unless the soldier is transferred to a civil sanatorium or hospital. In all cases, therefore, tuberculous ex-soldiers are brought under the supervision of the sanitary authorities. In the early part of 1916 attention was given to the prevention of the enlistment of men with definite tuberculosis. Ultimately the Board issued a general order under which Medical Officers of Health were required to supply the Army Council with lists containing the names and other particulars of all males on the notification register who were between the ages of eighteen and forty-five on January 1, 1916, and who had been notified during 1913-16. Lists of subsequent notifications are required to be supplied within a week of their entry in the register."

With regard to the very important subject of "Care and After-Care" the following observations appear: "Although the war has caused much delay in the development of the arrangements for care and after-care, a number of committees have been established on the lines set out in the Board's circular of April 29, 1915, and are doing good work. As a result of experience in dealing with the tuberculosis problem, the importance of this part of tuberculosis schemes is being more and more clearly recognized by the councils of counties and county boroughs. In particular, the importance is being recognized of providing patients with suitable work and of training them in suitable occupations under satisfactory conditions during the latter part of their period of treatment in sanatoria or immediately after their discharge therefrom. Unless treatment in a sanatorium can be followed in suitable cases by a period during which the patient is living and working under satisfactory conditions, much of the personal benefit of treatment may be lost. During the year the Medical Research Committee issued a report upon the incidence of Phthisis in the Boot and Shoe Industry, and recommended, *inter alia*, the establishment of a workplace for the manufacture of boots and shoes at a sanatorium, where convalescing operatives could carry on their trade under medical supervision and under satisfactory working conditions, the amount of work being determined medically for each patient. Some provision on these lines is likely to be made in the areas chiefly concerned in connection with the local tuberculosis schemes. Similar action may be taken with regard to other trades—*e.g.*, printers. In one area arrangements have been made for ex-sanatorium patients to occupy special

sleeping accommodation in the sanatorium grounds and to work part of the adjoining land as a market garden." In respect of the much discussed question of "Compulsory Isolation and Detention," the following report is made: "A public inquiry was held during the year to ascertain whether it was desirable that the powers of compulsory isolation given to St. Helens (Lancs) under a Local Act should be continued for a further period. The inquiry showed that during the four years the Act had been in force only one application had been made to a Court of Summary Jurisdiction for an order for the isolation of a tuberculous patient, and that in this case the Court had made an order for detention and maintenance for a period of three months. Although the powers conferred had only been used so sparingly, the possession of these powers had been found to be useful. In eighteen instances, during a period of two years, patients in an advanced stage of disease who had refused treatment in a residential institution had subsequently entered the hospital after informal notice had been given by the Medical Officer of Health that an order for isolation would be applied for. In a few instances also certain patients were prevented from taking their discharge from hospital by being informed that an application for an order for isolation might be made subsequently. There was no evidence that the Act had given rise to appreciable local friction or hardship, and no action appeared to have been taken which infringed the spirit of Article XVI. of the Public Health (Tuberculosis) Regulations, 1912. The Board accordingly extended the period for another five years."

It is interesting to note that "during the year a number of resolutions have been received from authorities urging that powers for compulsory isolation or detention should be given generally. It would be contrary to the public interests to grant these powers to a local authority unless an adequate number of beds for advanced cases of consumption were provided in that particular area."

## NOTES AND RECORDS.

THE Tenth Annual Report of the King Edward VII. Sanatorium, Midhurst, dealing with the year ending July, 1916, is much diminished from its usual size.[1] The Medical Superintendent, Dr. (now Major) Noel D. Bardswell, is still on active service. The seventy beds reserved for the treatment of non-commissioned officers are now available for civilians. Several interesting tables appear, giving data relating to ultimate results.

The last Report of the Canadian Association for the Prevention of Tuberculosis is a large volume, well illustrated, and containing particulars of work and the conduct of sanatoria in all parts of the Dominion.[2]

The British Dominions General Insurance Company, with true patriotic spirit and business enterprise, have issued an interesting and highly informing Year-Book dealing with war events and Empire

[1] King Edward VII. Sanatorium, Midhurst: Tenth Annual Report, July, 1915, to July, 1916. Pp. 15. Published at the King Edward VII. Sanatorium, Midhurst, Sussex, 1916.

[2] The Fifteenth Annual Report of the Canadian Association for the Prevention of Tuberculosis, 1915. Pp. 251. Secretary: George D. Porter, M.B., Bank Street Chambers, Ottawa, Canada.

problems.[1] The articles are by well-known experts, the leading contribution being by the late Lord Cromer. The illustrations and maps are numerous and excellent.

We strongly advise our readers to procure a copy of "The Empire Municipal Directory and Year-Book" for 1917.[2] This valuable annual is now in its thirty-fifth year. It will be found of the greatest service for reference. In convenient form particulars are provided regarding the population and undertakings of some 5,300 County, Borough, Urban and Rural District Councils, Port Sanitary Authorities, Municipal and Shire Councils, not only in Great Britain and Ireland, but in Canada, the Australian Commonwealth, the South African Empire, New Zealand, and all our overseas dominions. The names of the chief officers are given, and just such practical information as will meet the requirements of those engaged in public health, sanitary and other work connected with local government. The volume also contains an immense amount of practical instruction, and all is arranged in a methodical and effective manner. It is a book which every medical officer engaged in tuberculosis or any other form of public health work will find indispensable.

The last issue of *Evans' Journal* contains much practical information regarding venereal diseases, together with important notes on the technique of the simpler bacteriological methods.[3]

SPECIAL NOTE.—Dr. A. H. Miller, of the Joint Pathological Laboratory, Gartside Street, Manchester, whose article "On the Tubercle Bacillus" appeared in the last number of this Journal, requests the insertion of the following explanation and correction:

"I very much regret that in my paper on 'The Tubercle Bacillus' in the January issue of this Journal, on page 19, I made a statement which I now discover is a serious mistake. In my paper I said that Rost's leprosy streptothrix *lost* its acid-fastness on milk and on fish broth; on the latter very much so. Rost in his paper in 'Scientific Memoirs of the Government of India,' No. 42, states just the opposite—namely, that on milk his bacillus *regains its acid-fastness*, and on fish broth (rotten fish) very much so. This unfortunate mistake, arising through not referring to my notes made in April, 1916, does not, however, invalidate my implied contention, made in the next two lines of my paper—namely, that Major Rost did not first try to ascertain the staining properties (carbol-fuchsin) of his bacillus with carbol-fuchsin alone, and without the use of acids. On page 19, and half way down the page, the words 'to all intents to the same degree' should be deleted, and on this point reference may be made to my papers in the *Journal of Pathology and Bacteriology*. Further on, page 20, two-thirds of the page down, *after* the words 'on either side of the starting-point,' there should be *added* the words 'to right and left.'"

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[1] "The British Dominions Year-Book, 1917." Edited by Edward Salmon, F.R.C.I., and James Worsfold, F.C.I.S. Pp. 384. With coloured plates and maps. Published by the British Dominions General Insurance Company, Ltd., British Dominions House, Royal Exchange Avenue, London, E.C.

[2] "The Empire Municipal Directory of Local Authorities and Officials, and Year-Book of *Municipal Engineering and the Sanitary Record* for 1917." Pp. vi+224 and Diary. London: The Sanitary Publishing Co., Ltd., Proprietors of *Municipal Engineering and the Sanitary Record*, 8, Bream's Buildings, E.C. 1917. Price 5s. net. Post free in the United Kingdom, 5s. 6d.; abroad, 6s.

[3] *Evans' Journal*. Published by Evans, Sons, Lescher and Webb, Ltd., Liverpool and London.